AERONAUTICAL ENGINEERING REVIEW

INSTITUTE OF THE AERONAUTICAL SCIENCES

FEBRUARY 1949

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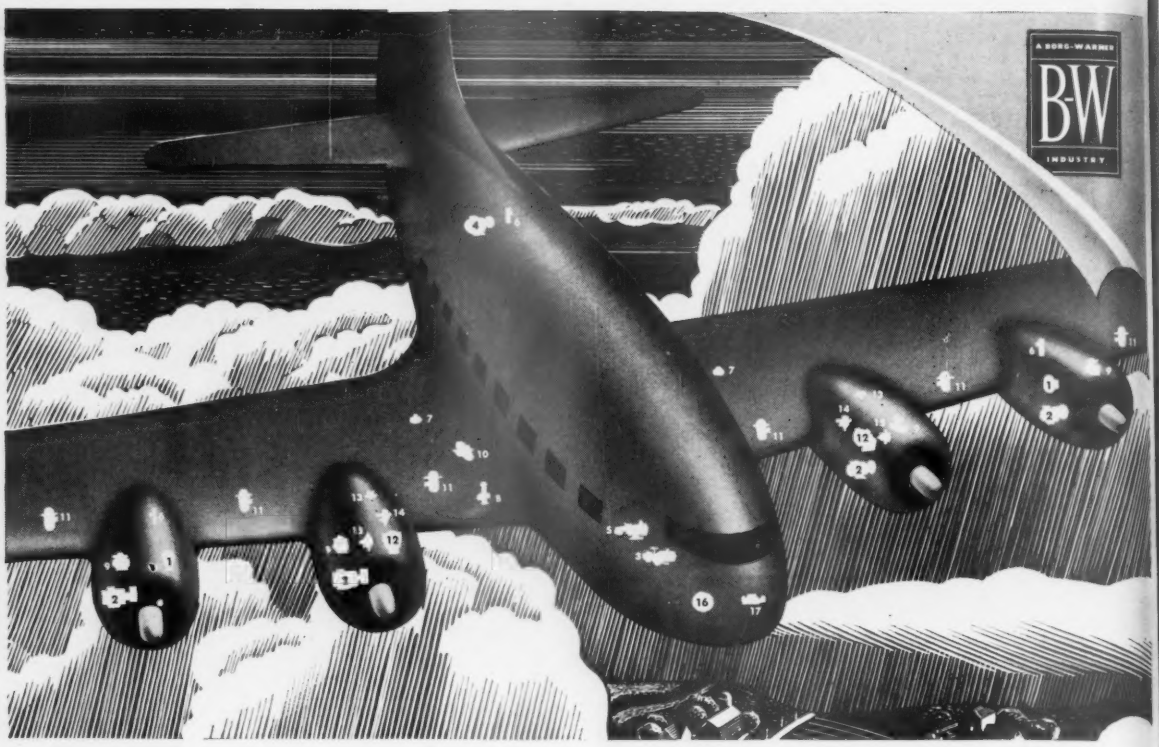

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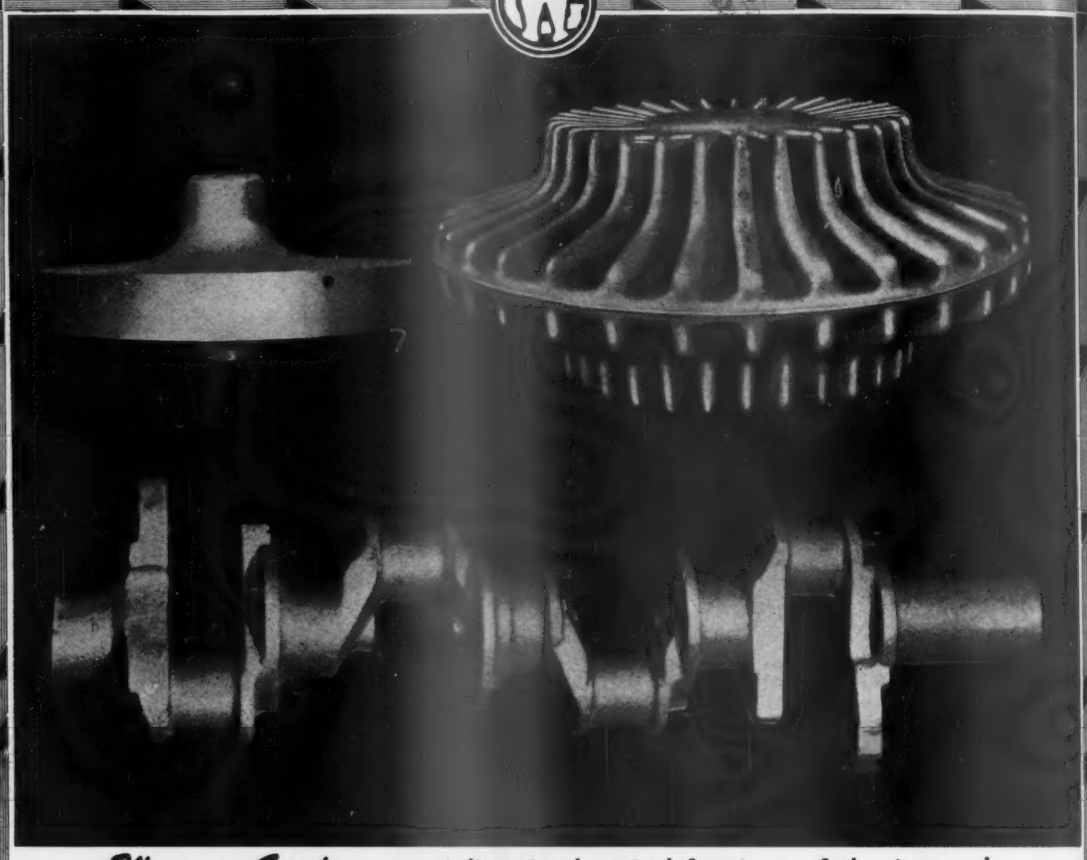

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SUBSCRIPTION RATES

Aeronautical Engineering Review: United States and possessions, 1 year, $3.00; single copies $0.50. Foreign countries including Canada (American Currency Rates), 1 year, $3.50; single copies, $0.50.

Entered as second-class matter at the Post Office, Easton, Pa., April 29, 1942. Acceptance for mailing at a Special Rate of Postage as provided for in the Act of August 24, 1912.

Publication Office: 20th & Northampton Streets, Easton, Pa.

Editorial Office: 2 East 64th Street, New York 21, N.Y.

Notices of change of address should be sent to the Institute at least 30 days prior to actual change of address.

Statements and opinions expressed in the *Aeronautical Engineering Review* are to be understood as individual expressions and not those of the Institute.

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AERONAUTICAL ENGINEERING REVIEW

Vol. 8 **FEBRUARY, 1949** **No. 2**

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I.A.S. News

A Record of People and Events of Interest to Institute Members

March 18 Date Set for Cleveland Meeting

Fourth Annual Flight Propulsion Meeting at Hotel Carter to Cover Three Phases of Improved Turbojet Engine: High-Pressure Compressors, Turbines, and Improved Combustion; Turbojet Thrust Augmentation to Be Timely Topic for Engine, Aircraft Manufacturers.

SPARKED BY THE CLEVELAND-AKRON SECTION PROGRAM COMMITTEE under the chairmanship of John H. Collins, Jr., the Institute of the Aeronautical Sciences' Fourth Annual National Flight Propulsion Meeting is scheduled for March 18 at the Hotel Carter, Cleveland. The program, as tentatively designed at this writing by the Committee, is a logical extension of the Wright Brothers Lecture by Abe Silverstein, who spoke on the improved turbojet engine in Washington, December 17, 1948.

▸ **Three Phases Covered**—As proposed by the Committee, three phases of the improved jet engine will be covered by papers selected for the following topics: Aircraft jet engine compressors, gas turbines, and combustion. In addition, there is a proposed evening session to be devoted to jet engine thrust augmentation and controls—a National Advisory Committee for Aeronautics session—which should prove to be a most timely topic for engine and aircraft manufacturers.

Under jet engine compressors, papers will range from high-pressure-ratio axial-flow compressors to multi-staged and supersonic compressors. High-pressure-ratio gas turbines also will be treated in the same session, expected to be held in the morning.

▸ **Jet Engine Combustion**—In the afternoon technical session, papers on turbojet afterburning, jet combustion, and ram-jet combustion (Bumblebee and Meteor) are proposed by the Committee.

Following dinner, the N.A.C.A. session in the evening on jet engine thrust augmentation and controls is expected to cover subjects on experimental studies of jet thrust augmentation, automatic controls of the augmented turbojet, and performance comparisons of thrust augmentation methods.

▸ **Supersonic Flight Talk**—The Committee hopes to obtain a prominent speaker for the Luncheon to talk on the subject of supersonic flight.

The Luncheon is expected to be held in the Carter's Ball Room, while the technical sessions will be held in the Rainbow Room.

A social hour, and possibly technical displays, will be held in the Rainbow Room Terrace.

Host for the meeting is to be Eugene E. Wasielewski, Chairman of the Cleveland-Akron Section.

The Section's Program Committee, who are working out the details of this important gathering, are, in addition to Chairman Collins, Ben Pinkel, Willson H. Hunter, H. Ellerbrock, Mr. Wasielewski, and S. D. Black, the Section Secretary.

Welcomer: *Eugene W. Wasielewski, Chairman of the Cleveland-Akron I.A.S. Section, will welcome Institute members and guests to the Fourth Annual Flight Propulsion Meeting in Cleveland, March 18.*

Mr. Wasielewski was elected Chairman of the local I.A.S. section in October, 1948. He previously had been Vice-Chairman of the Section. He is a Mechanical Engineer of N.A.C.A.'s Lewis Flight Propulsion Laboratory.

National Meetings Calendar

March 18	Flight Propulsion Meeting, Cleveland
April 28–29	Personal Aircraft Meeting, Wichita, Kan.
May 24–27	I.A.S.-R.Ae.S. Conference, New York
July 20–21	Annual Summer Meeting, Los Angeles

For details see page 41

Twelfth Wright Brothers Lecture: *Approximately 800 top-flight aeronautical engineers and scientists heard Abe Silverstein (right) deliver the Twelfth Annual Wright Brothers Lecture in Washington, D.C., December 17. Mr. Silverstein, Chief of the Wind Tunnel and Flight Division, Lewis Flight Propulsion Laboratory, N.A.C.A., spoke on "Research on Aircraft Propulsion Systems." (The full text of this paper will appear in an early issue of the JOURNAL OF THE AERONAUTICAL SCIENCES.)*

Stack, Bell, Yeager Awarded N.A.A. 1948 Collier Trophy

President Truman, on the 45th anniversary of the first powered airplane flight by the Wright Brothers December 17, presented to the three men "most responsible" for attaining supersonic speeds in flight the Collier Trophy, one of the highest aviation honors.

▶ **Greatest Achievement**—The three recipients were John Stack, Assistant Chief of Research, N.A.C.A., Langley Field; Lawrence D. Bell, President of Bell Aircraft Corporation; and Capt. Charles E. Yeager, U.S.A.F.

The National Aeronautical Association, custodian of the Trophy, said in announcing the award that flight faster than sound was the "greatest aeronautical achievement since the original flight of the Wright brothers' airplane" in 1903.

Mr. Stack, an I.A.S. Fellow, was cited for "pioneering research to determine the physical laws affecting supersonic flight and for his conception of transonic research planes."

Mr. Bell, an Associate Member and Member of the Council of the Institute, was honored for "the design and construction of the special research plane X-1."

Captain Yeager was named as having, on October 14, 1947, "first achieved human flight faster than sound."

Big Air-Line Merger Agreement by Pan Am, American Overseas

Agreement for one of the largest mergers in the history of aviation was concluded in the middle of December by Pan American World Airways and American Overseas Airlines. Details of the proposed merger, subject to approval by C.A.B., calling for transfer of all assets of American Overseas to Pan Am in exchange for P.A.A. stock, are expected to be completed in about 5 months.

▶ **Voting Trust**—Although the move would make American Airlines, which owns some 62 per cent of the capital stock of A.O.A., a major stockholder in Pan American, announcement of the agreement to the merger stated specifically that American "has no plan to take part in the management of Pan American."

Stock received by American is to be placed in a voting trust reportedly consisting of three members—one nominated by Pan American, one by American, and the third a neutral member acceptable to both principals.

Slightly more than 20 per cent of the capital stock in A.O.A. is owned by American Export Lines.

▶ **Better Financial Position**—Juan T. Trippe, I.A.S. Associate Member and President of Pan American, said that "the financial position of the carriers would be strengthened and the opportunity of preserving a fair share of North Atlantic air traffic under the American flag would be greatly improved" and that "important operating economies would be effected" as a result of the proposed merger.

Pan American, which is taking delivery on its first Boeing Stratocruisers would take over the eight Stratocruisers ordered by American Overseas, as well as the Lockheed Constellations and DC-4's now operated by A.O.A., totaling 14 four-engined aircraft.

Four I.A.S. Members Elected by Stratos Corporation Board

J. Carlton Ward, Jr., I.A.S. Member and Chairman of the Fairchild Engine & Airplane Corporation board, was elected by the board of directors of Stratos Corporation, wholly owned subsidiary of Fairchild, to head the Stratos board.

Together with Mr. Ward's election, were the elections of Lawrence B. Richardson, Fairchild President and I.A.S. Fellow, as President, and Myron B. Gordon, Associate Fellow and Fairchild Vice-President, Operations, as Vice-President of Stratos.

F. Eugene Newbold, an I.A.S. Member and formerly with Ranger Aircraft Engines Engineering Operations, was appointed General Manager of Stratos Corporation effective January 1, 1949.

Lebanon Steel Foundry New I.A.S. Corporate Member

Lebanon Steel Foundry, which produces carbon, low structural alloy and stainless-steel castings, is latest recruit to ranks of Institute of the Aeronautical Sciences corporate members.

Lebanon Steel, which acquired rights to American use of British-de-

Chairman and Discussers: *Dr. Clark B. Millikan (left), Chairman, Wright Brothers Lecture. Prepared discussions of Mr. Silverstein's lecture were given by (left to right): E. S. Taylor, Professor of Aircraft Engines, M.I.T.; R. M. Hazen, Director of Engineering, Allison Division, G.M.C.; Abe Silverstein; O. E. Rodgers, Manager of Development and Research Engineering, Aviation Gas Turbine Division, Westinghouse; and E. S. Thompson, Manager of Sales, Aircraft Gas Turbine Division, G-E.*

veloped secret Centri-Die process of centrifugal casting in permanent molds, gave an initial public showing in this country of the Centri-Die alloy steel castings.

▸ **Primary Source**—The Lebanon, Pa., company is one of the aviation industry's prime sources of heat-resistant steel alloy castings for jet engines and other exacting applications.

In recognition of its contribution to alloy steel development, the American Society for Metals conferred its distinguished service award on William H. Worrilow, President of Lebanon Steel Foundry, during the 30th National Metal Congress & Exposition in Philadelphia.

▸ **Leader in Field**—Known as a leader in its specialized field, Lebanon Steel has been a pioneer in American engineering and metallurgical research. During World War II it developed the cast armor plate, which became the standard for armor-producing companies throughout the country.

Recently, under exclusive licensing arrangement with Firth-Vickers Stainless Steels Ltd., the company introduced the war-perfected Centri-Die process for centrifugal casting of superalloy ring components required in gas-turbine construction.

Marquardt Aircraft to Use New High-Speed Tunnel

Marquardt Aircraft Company has been in the process of moving from its Venice quarters to plant facilities totaling 26 acres adjacent to the Metropolitan Airport in Van Nuys, Calif. The administrative and technical personnel have been at work in the new plant since late last year. Entire move is expected to be completed sometime next spring.

Test facilities at Venice will be used until March, at which time it is anticipated that a new high-speed wind tunnel for testing supersonic jet engines will be completed at Van Nuys. Marquardt Aircraft, which was erroneously reported in the November, 1948, issue of the AERONAUTICAL ENGINEERING REVIEW to be a subsidiary of Aerojet Engineering Corporation instead of The General Tire & Rubber Company, the parent body of both, plans to increase its personnel from approximately 100 to 400 this year.

The new Marquardt quarters were originally built by the Timm Aircraft Company and consist of seven buildings with a total of more than 100,000 sq. ft. covered floor space.

Gifts to the Institute Collections

Over 60 slides illustrating the history of aircraft up to World War I were received from Major Manfred Pakas. The earliest aircraft represented was Henson's Aeriel of 1842. A number of photographs, clippings, and over 30 books, including the *Gold Star Album* of Charles Blumenthal, New York, 1928, and the *History of the 77th Division*, 1919, were included. Dr. Alexander Klemin added 30 books to his previous generous gifts, including Ramsey's *Hydrodynamics*, London, 1913, and the *Jahrbuch für Luftverkehr*, 1924–1927.

Technical reports were received from the Institute of Navigation, courtesy of Paul Rosenberg; the Cornell Aeronautical Laboratory, courtesy of Miss Elma T. Evans, and the University of California. A doctoral thesis by Richard Schamberg, *The Fundamental Differential Equations and the Conditions for High Speed Slip-Flow*, was received from the California Institute of Technology through the courtesy of Dr. Clark B. Millikan and Miss Katherine McColgan. Two reports on *Airport Runway Evaluation in Canada* were received from Norman W. McLeod, of the Highway Research Board of Canada.

Six technical bibliographies were received from the Bureau of Ships. A file of its *Guide to Russian Scientific Literature* was received from Brookhaven National Laboratory. Manuals of various airplanes were received from the Curtiss-Wright Corporation through the courtesy of William K. Ebel. Two copies of his *Simplified Introduction to High Speed Flight* were received from Major T. F. Weldon.

Additional gifts were received from the Douglas Aircraft Company, Inc.; Pan American World Airways System; Pennsylvania Aeronautics Commission; Herman Schoenen; San Francisco Public Utilities Commission; Transcontinental and Western Air, Inc.; and U.S. Naval Aviation Supply Depot in Philadelphia.

Official U.S. Navy Photograph

New Jet Self-Starter: *AiResearch Technical Assistant Florence Miller holds jet engine self-starter beside bleed-off version of gas turbine, compressed air from which is used to operate the starter. The 88-lb. turbine produces 65 equivalent hp. at sea level.*

AiResearch Develops First Jet, Turboprop Self-Starter

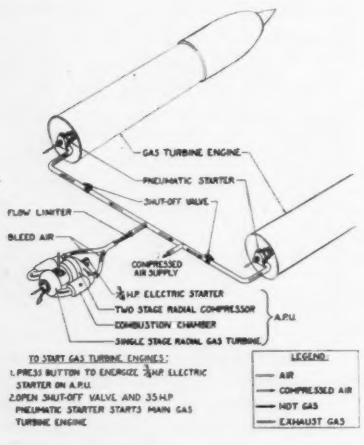
The first successful jet and turboprop aircraft-engine self-starter has been developed by AiResearch Manufacturing Company, Los Angeles, and the Navy Bureau of Aeronautics.

New self-starter system eliminates use of cumbersome storage batteries or other heavy auxiliary power units outside the plane. System utilizes as its major component a newly developed small gas turbine weighing 88 lbs. Highly compressed air is bled from this turbine to operate a high-speed air turbine starter unit, which is attached directly to the jet or turboprop engine.

▶ **Saving in Time**—Rear Adm. Theodore C. Lonnquest, U.S.N., Assistant Chief of BuAer for Research & Development, an I.A.S. Honorary Member, said: "The development of this small, powerful turbine and the self-starter system for our jet engines is of the utmost importance. It will, of course," he added, "be a great saving in time, equipment, and man power and, further, will make our jet planes all the more versatile."

Another advantage of the self-starter system is that it will allow jet or turboprop aircraft to use out-of-the-way bases not equipped to start their engines. It requires only a $^3/_4$-hp. motor and one storage battery for its own starting.

The turbine engine that powers the starter also can be used for cabin pressurization, air conditioning, heating, and deicing and to operate other power-consuming devices.



Self-Starter System: *AiResearch pneumatic starter system for jet and turboprop engines. The high-speed air turbine starter unit is attached directly to jet or turboprop engine.*

I.A.S. Newslines

▶ **J. Lee Atwood,** President, North American Aviation, Inc., a Fellow, was given the Presidential Certificate of Merit by Assistant Secretary of Air Force Eugene M. Zuckert for his outstanding contribution to the war effort.

▶ Turbine Engineer . . . **Guy E. Beardsley, Jr.,** has been appointed Turbine Development Engineer at Pratt & Whitney Aircraft Division, United Aircraft Corporation. An Associate Fellow, he had been Assistant Chief Engineer.

▶ Honorary Membership . . . **Dr. Lyman J. Briggs,** I.A.S. Fellow and Director Emeritus of the Bureau of Standards, who has spent 49 years in technical service of the Government, received an Honorary Membership in the American Society of Mechanical Engineers at the society's 69th Annual Meeting in New York.

▶ No Red A-Bomb 'Til '50's . . In opinion of **Dr. Karl T. Compton,** Chairman of Research & Development Board, an I.A.S. Fellow, the Soviet government would probably not have the atom bomb until "sometime in the 1950's." Speaking of his new post, Dr. Compton said he accepted it for a tour of duty for no longer than 3 years.

▶ Immediate merger of the Air Force and Navy air arm was urged by **James H. Doolittle,** Honorary Fellow, to halt waste of "unnecessary billions" of defense dollars. Having two separate air forces violates the fundamental law of sound military organization, Doolittle added, writing in *Air Force* magazine.

▶ Discounts Rocket Power . . . **Dr. Hugh L. Dryden,** Director of Aeronautical Research, N.A.C.A., and I.A.S. Honorary Fellow, speaking at joint dinner of A.S.M.E. and its affiliate, American Rocket Society, said that, because of high fuel consumption, it is doubtful whether the rocket engine will find useful application as a principlal power plant in a practically useful aircraft.

▶ Wright Brothers Trophy . . . **Dr. William Frederick Durand,** 89, Professor Emeritus of Mechanical Engineering, Stanford University, was first recipient of the Wright Brothers Memorial Trophy, which was presented at the annual Aero Club dinner on December 17. Dr. Durand, an Honorary Fellow, is the dean of American engineers and helped establish the N.A.C.A. The Trophy was founded by Dr. Godfrey Lowell Cabot of Boston, long active in aviation.

▶ With Navy . . . **Bruce G. Eaton, Jr.,** former Chief Design Engineer, Pilotless Aircraft, Curtiss-Wright Corporation, Columbus, is working with the Navy as Associate Director, Pilotless Aircraft Development Laboratory, on guided missiles. Mr. Eaton is an Associate Fellow.

▶ Postponed . . . **Major Gen. Oliver P. Echols,** Associate Fellow, previously reported here as assuming full duties as Chairman of the Board, Northrop Aircraft, Inc., in December, actually is scheduled to take over this month, having in the meantime been re-elected President of Aircraft Industries Association to continue in that post until a successor is chosen by A.I.A.

▶ Melville Prize Winner . . . The 1948 Melville Prize Medal, given by the American Society of Mechanical Engineers, was won by **Reginald E. Gillmor,** Vice-Chairman of the National Securities Resources Board, Washington, D.C., for an original paper on an engineering subject, "The World the Manager Lives In." Mr. Gillmor, an Associate Fellow, formerly was Vice-President for Public Relations, The Sperry Corporation.

▶ Aids Rocket Study . . . **Harry F. Guggenheim,** an Honorary Member and President of the Daniel and Florence Guggenheim Foundation, announced that two national centers of jet and rocket propulsion study and research have been underwritten by the Guggenheim Foundation. Emphasis will be on peacetime uses of rockets and gas turbines. One center is at Princeton and the other at Cal

Tech. Fund of $500,000 has been set aside for the use of the researches.

▸ With Smith-Morris Company . . . **Thomas N. Kelly,** Associate Fellow, former Project Engineer—Jet Engines, Continental Aviation & Engineering Corporation, has been working at Smith-Morris Company as Chief Engineer and General Manager for the past several months.

▸ Merited . . . **J. H. "Dutch" Kindelberger,** Chairman of the Board of North American Aviation, Inc., was presented with the Presidential Certificate of Merit for outstanding contribution to the war effort early last December. Mr. Kindelberger, a Fellow, said the award was a reflection of the outstanding effort of many thousands of North American's employees.

▸ Teaching in Vienna . . . **Dr. Leo Kirste** is Professor for Light Structures, Technical University, Vienna, Austria. Dr. Kirste is an Associate Fellow and has been at Technical University since 1937.

▸ Land Decorated . . . For his outstanding services in promoting cause of Norwegian-American relations, **Emory S. Land,** President, Air Transport Association and I.A.S. Fellow, was presented with the Commander's Cross with Star of the Royal Order of St. Olav.

▸ F. S. F. Representative . . . **Eugene W. Norris,** former Vice-President—Engineering, Luscombe Airplane Corporation, has been Washington Representative of Flight Safety Foundation for the past several months.

▸ Heads Speakers . . . **Del W. Rentzel,** C.A.A. Administrator and I.A.S. Honorary Member, heads the group of outstanding speakers addressing third Air Transportation Institute meeting currently conducted by The American University. Meeting, which began January 18 and carries through February 11, is presenting an intensive curriculum on vital issues in air transport field for officials and future executives.

▸ Administration Watchword . . . "Remember Pearl Harbor" is the Administration's watchword in making military and diplomatic decisions, Secretary of Air Force **W. Stuart Symington,** I.A.S. Honorary Member, said in speech before Norfolk (Va.) Association of Commerce on seventh anniversary of Japan's attack on Pearl Harbor. Unification of armed services was major lesson learned from the disaster, he declared.

▸ Awarded Fraternity Medal . . . **Walter G. Vincenti,** Associate Fellow, received the Pi Tau Sigma Gold Medal Award for 1948 at the Annual Dinner of the A.S.M.E. in New York City on December 1.

▸ Honorary Professor . . . **Dr. Theodore von Kármán** has been named an Honorary Professor of Mechanical Engineering at Columbia University. He is the third person in the university's history to receive the honor. Dr. von Kármán, an Honorary Fellow, also received in person the John Fritz Medal, December 1, for which he was cited last February at the A.S.M.E. meeting in New York.

SUBSONIC ZONE EXPLORER

Newest research aircraft, X-4, built by Northrop Aircraft, Inc., is one of the smallest planes ever built for the U.S. Air Force. Intended to explore flight characteristics in the subsonic zone, elaborate N.A.C.A. instrumentation will record results of tests on the plane, which is about 20 ft. long and has wing span of approximately 25 ft. Controls are patterned after Northrop Flying Wing, in that it uses "elevons" built into trailing edge of the wing, while single vertical fin and rudder provide lateral stability and control. New plane has pilot ejection seat and tricycle landing gear and is powered by twin gas turbines.

Corporate Member News

• Adding Production Space . . . **Airborne Instruments Laboratory, Inc.,** has acquired 10,000 sq.ft. of production space in a building located at 61 Second St., Mineola, L.I. Obtained on a 5-year lease, additional space will be used to house the Lab's Engineering and Production Division and will be occupied early this year. Airborne, which also is building a $250,000 research lab at Plainview, L.I., on a 72-acre tract purchased early in December, is placing increased emphasis on production activities following an internal reorganization. Staff has increased to 330 persons.

• Economy Program . . . A far-reaching economy program is being put into effect by **American Airlines,** concurrent with the tapering off of its training program and standardization of several plane types. American, which made an agreement with Pan American World Airways for a merger of its international division, - American Overseas Airlines, with P.A.A., expects to make money this year, with break-even factor dropping to 50 per cent this spring . . . American has sold its office building at 910 S. Boston St., Tulsa, to a Providence, R.I., realtor in line with policy not to engage in real-estate business. Company now is a tenant of the Albert Gould firm, purchaser of the building.

• Regains Postwar Losses . . . **Beech Aircraft Corporation's** annual statement for fiscal 1948 shows company earned enough after taxes to balance its previous postwar net losses and come out $168,228 ahead of its 1945 financial position, as adjusted by renegotiation. Net income for 1948 was $2,213,626, compared with aggregate postwar net losses of $2,045,398 incurred in the 1946 and 1947 fiscal years. Net sales for 1948 were $24,141,120 compared with net sales of $26,211,411 for fiscal 1947.

• **Bell Aircraft Corporation,** with sales at $10,907,943 for 9-month period ended last September 30, compared with $10,645,705 in same 1947 period, reported a net loss of $412,531. Net deficit for previous year was $381,163 in like period. Costs, including

Silicone News

DC SILICONES

Flying Jennys to Jets

In the days of the flying Jenny and the cow pasture airport, comfort was a luxury few airmen had time to consider. Keeping out of the tree tops was a more constant problem than keeping fingers from freezing. But in the sleek new airliners, passengers expect drawing-room comfort. That requires creative engineering because both high and low temperatures are involved and only such relatively new materials as the Dow Corning Silicones can take both extremes.

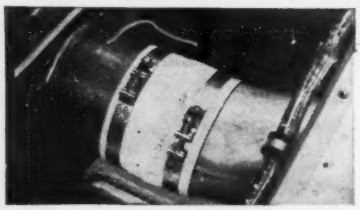


PHOTO COURTESY ARROWHEAD RUBBER CO.

Silastic-coated glass cloth heating duct seals withstand continuous long time exposure to operating temperatures between 350° and 400° F. in new Consolidated Vultee Convair-Liners.*

In designing the new Convair-Liner, Consolidated's engineers faced heating and ventilating duct conditions that would frizzle any conventional material; maximum temperature 450° F.; operating temperature, 350°-400° F.; internal air temperature, 250°-350° F.; internal pressure, 10 in. of water; misalignment, ⅛ to ¼ inch; vibration from mild to extreme.

That's the problem Consolidated presented to Arrowhead Rubber Company of Vernon, California. Engineers at Arrowhead solved this problem with a Silastic tube reinforced with glass cloth. Arrowhead also uses Silastic,* the rubber-like silicone by Dow Corning to produce duct seals that have high performance records at temperatures from −89° to 450° F. and under pressures up to 150 p.s.i. in the newest type jet planes.

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development and experimental and depreciation, were $12,210,674, compared with $12,262,782 in 1947 when a carryback tax refund of $945,000 was received.

• Special Year-End Payment . . . **Bendix Aviation Corporation** paid a special year-end dividend of $0.50 a share and a quarterly dividend of $0.50 December 29 to shareholders of record on December 10.

• B-50 Flies 9,400 Miles in Refueling Flight . . . A 9,400-mile flight was completed by a **Boeing Airplane Company** B-50 Superfortress during which it was refueled three times in mid-air from tanker B-29's. Plane flew from Ft. Worth, Tex., to Hawaiian Islands and back in slightly more than 40 hours. "A sizable useful load of bombs" was dropped at the halfway point to illustrate possible effectiveness of flight refueling technique on long-range missions. B-50 is one of 390 in the new series of B-50 or B-54 types either already delivered or under construction. Even with normal fuel supply, Boeing says, the B-50 is capable of carrying a 5-ton bomb load 6,000 miles.

• Air Force Orders Cessna 195's . . . **Cessna Aircraft Company** received a firm order from the Air Force for about $400,000 worth of Cessna 195 aircraft and spare parts. Service designation of the 195 is LC-126A-CE.

• New Type Thermal Anti-Icing Approved . . . C.A.A. has approved a new type thermal anti-icing system for Convair-Liner, according to **Consolidated Vultee Aircraft Corporation.** System utilizes heat from exhaust gases. Outside air first is drawn round engine and the heated air is further heated by being ducted round augmentor tubes, after which it is ducted to wing and tail leading edges. Tests in Pacific northwest demonstrated system's ability to satisfactorily prevent ice and remove it. It also functions satisfactorily on one engine.

• Engine research plant in Detroit has been sold by War Assets to **Continental Motors Corporation** for $126,000. Continental had been leasing the plant.

• Lends Engineers to Boeing . . . A lend-lease program is bringing aviation engineering talent from **Curtiss-Wright Corporation,** Columbus, to temporary assignments with Boeing's Seattle plant. Short of experienced, qualified engineering personnel, Boeing has borrowed 45 of C-W engineers with 30–40 more expected to go west.

• New Air Force Trainer . . . The XT-30, new Air Force trainer, which was completed in mockup stage by **Douglas Aircraft Company, Inc.,** in the middle of last December, is an experimental single-engined model with conventional low wing, powered by Wright R-1300 engine rated at 800 hp. on take-off. Engine location is immediately aft of cockpit and drives prop by shaft under the cockpit floor. Plane will have top speed of 286 m.p.h. at 10,000 ft., endurance of 6¼ hours at 190 m.p.h., and service ceiling of 29,600 ft. Design gross weight is 5,999 lbs. Wing span is 36 ft. 4 in.; length, 36 ft. 9½ in.; height, 13 ft. 6½ in. Tricycle landing gear and tandem seats are provided. Contract provided for engineering and mockup.

• G-E Opens New Research Unit . . . Heart of a new $18,000,000 research lab was opened by **General Electric Company** near Schenectady early last December. Expected to be completed in 1950, new lab will be for fundamental, as well as practical, research, one of the biggest projects being "Operation Cirrus," in which nature of clouds is being studied.

• New Goodrich De-Icer . . . An aircraft deicer capable of overcoming severe icing conditions in the narrow intake of a jet engine—one of greatest headaches in supersonic flying—has been developed by the aeronautical division of **The B. F. Goodrich Company.** Utilizing electrically heated rubber—a thin, tough rubber with core of resistance wires running through it —Goodrich engineers fabricated a special rubber lining for the jet diffuser cowl, through which air flows to the combustion chamber.

• Pays Dividend . . . **Grumman Aircraft Engineering Corporation,** on December 21, paid a $1.00 dividend on the common to shareholders of record on December 11. Total dividends paid for year was $2.00 a share, $0.50 more than in 1947.

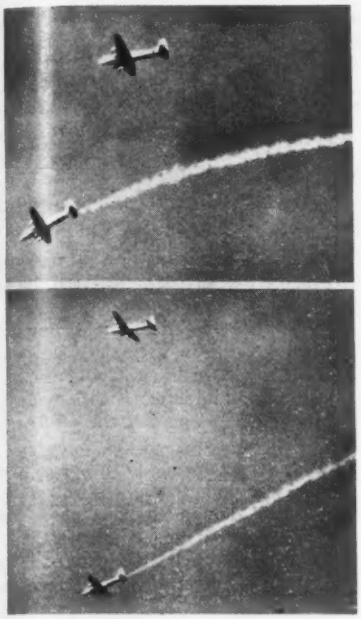
• Aerol Bought by Lockheed . . . The Aerol Company, Los Angeles, makers of hand trucks, wheels, casters, and newly developed watertight wheel, has been purchased by **Lockheed Aircraft Corporation.** Company is continuing under its own name as a division of Lockheed's wholly owned subsidiary, Airquipment Company.

• Air Force to Get Ten More Flying Wing Jets . . . New Air Force order calling for converting ten more prop-driven B-35 Flying Wing aircraft to jet propulsion has been received by **Northrop Aircraft, Inc.** Conversion work will require about 1 year, work being done at Northrop factory at Hawthorne.

• Pan Am Gets 20th Convair-Liner . . . **Pan American World Airways** took delivery of the 20th and final Convair-Liner type Clipper from Consolidated Vultee Aircraft in December. Ferried to Miami from San Diego, the Clipper that completes the $10,000,000 order will enter service on Pan Am's Latin American routes in the Caribbean area . . . Centralization of P.A.A.'s system-wide Clipper maintenance in Miami has resulted in sharp increase in size of Pan American's "family" at the Florida gateway city. In addition to hiring hundreds of new workers in the state, P.A.A. has transferred 150 employees from other cities—128 from New York alone.

• Streamlined Engineering . . . **United Air Lines, Inc.,** has streamlined its engineering setup by regrouping all divisions of maintenance and engineering and consolidating important engineering functions. Under new organization, four engineering executives at Denver base are now at San Francisco, where each is in direct control . . . U.A.L. has concluded an interline air-cargo agreement with British Overseas Airways Corporation.

• Ultrasonic "Stethoscope" . . . Enabling engineers to examine solid pieces of steel by means of sound waves, an ultrasonic "stethoscope" has been devised by **Westinghouse Electric Corporation.** With new technique, ultrahigh-frequency sound



REVERSING PROGRESS
Curtiss-Wright demonstrates how "reversing" of plane's propellers in flight "brake" the speed of a multiengined airliner and enable it to descend during emergency or procedure letdowns safely in less than half the time formerly required. Two four-engined aircraft—a C-54 equipped with reversible propellers (smoke trail) and a DC-4 using conventional props—flying together at an altitude of 15,000 ft., were suddenly instructed to make emergency landings. The C-54, utilizing its reversible props, dropped at a 40° angle at a rate exceeding 10,000 ft. per min. to make a quick landing, while other plane had to wind its way down in the usual circles.

waves are transmitted through massive steel parts. By using a crystal similar to that in phonograph pickup arms, electrical impulses are changed into sound waves. Projected through metal, sound waves reveal tiny cracks, cavities, or foreign particles and reflect sound back to crystal. Changed into electrical impulses, these reflections appear as bright vertical lines on viewing screen of electronic receiver. By measuring time it takes sound waves to go through metal and bounce back to crystal, metallurgists find exact location of any flaw. When flawless throughout, sound waves reflect from opposite side of object. Reflected sound reveals quality of metal as accurately as an X-ray, while penetrating thicknesses X-rays cannot reach . . . Westinghouse is rushing construction of world's brightest lights for installation by U.S.A.F. at German airports used in Berlin airlift. A six-light system will be installed at each of seven airports, including Tempelhof, to reduce fog, snow, and rain hazards.

• The Wright Move . . . **Wright Aeronautical Corporation's** sales and field engineering office on the West Coast has been moved to 6030 Wilshire Blvd., Los Angeles 36. Company's service representatives remain at Grand Central Air Terminal.

Necrology

W. J. Blanchard

Werner J. Blanchard, General Manager of Aeroproducts Division, General Motors Corporation, was killed in an airplane crash on December 6, 1948. Mr. Blanchard, age 48, had been a Member of the I.A.S. since 1943.

▸ **In Aviation 21 Years**—At the time of his death, Mr. Blanchard had spent some 21 years in the aviation industry, beginning with the Curtiss-Wright Propeller Division as an Engineer.

He was President of Blanchard & MacNeil (1936–1937) and of Engineering Projects (1937–1940) before accepting the post of General Manager of Aero-products Division in 1940.

At the Curtiss plant he was in charge of development of the Curtiss controllable-pitch propeller and hub. At Blanchard & MacNeil and, later, at Engineering Projects, Inc., he directed the development of the propeller blade and hub designs that are manufactured by Aeroproducts Division.

Mr. Blanchard was graduated from Kansas State College in 1924 with a B.S. in Mechanical Engineering. He was a member of the Society of Automotive Engineers and the Engineers' Club, Dayton.

John Rogers

John Rogers, Works Manager and Process Engineer for aircraft work at Metlab Company, metallurgical laboratories, Philadelphia, died November 29 at the age of 44. He was Secretary of the Philadelphia Section.

▸ **British Born**—Mr. Rogers, born in Nottingham, England, in 1904, was brought to this country in 1905. He was educated at Cheltenham High School, Drexel Institute, and Temple University.

In 1934 he was employed at the Metallurgical Laboratories, working on heat-treating of aircraft components. Next, he became an Instructor in Aircraft Mechanics at the Rising Sun Aircraft School in Philadelphia, where he remained 2 years, subsequently becoming an Instructor at the State Trade School, Conn., in Aircraft and Aircraft Engine Mechanics.

In September, 1939, he returned to the Rising Sun School in Philadelphia to become Instructor and Director. During the war he was Civilian Director, Army Air Forces Training Detachment at Rising Sun School; Supervisor—Engineering, Science & Management, War Training Program, Temple University; and Supervisor of Method, Platt-LePage Aircraft Company. He joined Metlab as Process Engineer in May, 1945.

He was a member of the American Society of Metals, the Franklin Institute, the American Management Association, and the Masonic Order, as well as of the Institute of the Aeronautical Sciences.

I.A.S. Sections

Cleveland-Akron Section

Dr. S. D. Black, *Secretary*

With 150 members in attendance, Vice-Chairman O. W. Loudenslager opened the November 23 meeting at which Dr. G. L. Shue, Chief of Aerodynamics, U.S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md., was the principal speaker.

▸ **Tunnel Techniques**—Title of Dr. Shue's talk was "Tunnel Techniques and Experiences at the New U.S. Naval Ordnance Laboratory Supersonic Tunnel Test Facility." It was followed by an inspection tour of the Guggenheim Airship Institute, Akron, where the meeting took place.

Dayton Section

W. A. Barden, *Secretary*

"Psychological Research Applied to Aeronautical Engineering Problems" was the subject of a talk presented by Dr. P. M. Fitts, Chief, Psychology Branch, and Dr. W. F. Grether, Chief, Cockpit Unit, both of the Aero Medical Laboratory, Wright-Patterson Air Force Base, at the December 2 meeting; Lt. Col. A. A. Arnhym, Chairman, presided.

▸ **Psychology and Instruments**—Dr. Fitts described in considerable detail the work of the Psychology Branch in studying accidents resulting from pilot

(*Continued on page 13*)

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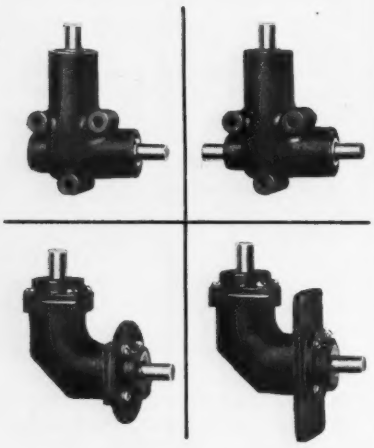

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Meet Your Section Chairman

O. J. Schaefer

Baltimore Section

Oswald John Schaefer got into aeronautics by an accident of acoustics—enrolled in a chemical engineering course at the University of Michigan, the professor's voice, by the time it reached the Schaefer ears in the back row, was so faint as to be inaudible. Having endured this intolerable situation as long as he could, the budding chemical engineer switched to an aeronautical engineering course, and what was chemistry's loss is aviation's gain.

Today he is Assistant to the Vice-President of Engineering of The Glenn L. Martin Company, on whose staff he has remained for the past 19 years.

▶ **Son of Glassmaker**—Born in Hannover, Germany, in 1904, Mr. Schaefer is the son of a famous maker of scientific glass instruments. His father still operates his own plant in Detroit—the family having migrated to this country in 1911. By 1916, they were as far west as Ann Arbor, Mich., where young Schaefer went to grade and high schools.

During his high-school days, the boy learned glass blowing, helping his father in his vacations.

Also, by the time he left high school and entered the University of Michigan, he was a pretty good violinist and augmented his finances by sawing fiddle in a theater pit or with a dance orchestra, helping to put him through college.

▶ **Doubles in Brass**—Following his graduation in 1927 with a bachelor's degree in aeronautical engineering, Mr. Schaefer went to work with the Hess Aircraft Company, Wyandotte, Mich., which made and sold small airplanes. Never, however, did it make enough to keep out of the red, and young Schaefer had to double in brass. In the front office he designed planes and parts, then he whipped into the factory to build what he had so carefully thought up.

The first plane Mr. Schaefer worked on was later entered in the famous Dole race from California to Hawaii. The pilot started out all right but soon turned back, saying he had run into a storm.

A few years later, the Hess company was moved to Alliance, Ohio, becoming the Alliance Aircraft Company, designers and builders of small airplanes and engines. One day the wolf came in the door.

Mr. Schaefer and another man were doping a wing when a stranger entered and demanded his name. Mr. Schaefer gave it, together with the information that he worked there. "Not any more," the stranger informed the engineer. "I'm the sheriff. This place is closed up."

▶ **Seeks Permanence**—It behooved Mr. Schaefer, who had been married in Alliance in 1929 to Miss Lucile E. Eddleblute of that city, to get on a payroll with more permanent characteristics, and out of several opportunities he chose The Glenn L. Martin Company, which he joined in 1930 shortly after the plant was moved to Middle River.

Coming in as a draftsman, he lasted one day at the job. Another Hess alumnus, Drew Helwig, who had preceded Mr. Schaefer to the Martin company, told his boss that Mr. Schaefer was a whiz as a stress engineer, and on his second day there he had a new job.

In succeeding years he was chief draftsman on the Model 156, the Soviet Clipper; assistant project engineer and project engineer on the 167 Maryland; and project engineer on the 187 Baltimore. Eventually he became Fuselage and Hull Design Engineer, Chief Design Engineer, and Chief of Design Section. He was named Assistant to the Vice-President of Engineering last year.

In 1936 he coauthored a series of articles with S. A. Kilpatrick on the "Design of Thin-Sheet Aluminum Alloy Sections" for the magazine, *Product Engineering*, which ran in the February, March, April, and May issues.

By way of diversion, Mr. Schaefer, who has two children, the elder of whom appears to have a bent toward aeronautical engineering, likes to play his violin, go golfing and fishing when he gets the chance, or play bridge. He reads in what spare time is left.

(*Continued from page 11*)

error in order to determine the cause of the errors.

Dr. Grether covered specifically the work that is being done in the matter of instrument design. Such factors as panel layout, normal position of indicator, alignment of indicators of instruments in a group, etc., were discussed in detail.

Hagerstown Section

J. Anthony Pauli, *Secretary*

The meeting of November 23 was opened by Herman Wieben, Chairman, with 34 members and guests present.

As new business, Mr. Wieben named new committees and members for the Hagerstown Section as follows: Program Committee—Chairman, Carl J. Wenzinger, members, A. J. Thieblot, K. P. Bowen, and M. J. Frank; Membership Committee—J. O. Gibson, Chairman, and B. A. Lindner, J. Tillou; Activities Committee—H. J. Sieradzki, Sr., Chairman; Publicity Committee—D. W. Weller, Chairman, and J. M. Crook; Technical Advisory Committee—Roy Lessard, Chairman, and Earl E. Morton; and Social Committee—M. A. Cawl, Chairman, and J. A. Pauli, R. Ziegenfuss.

▸ **Refrigerated Tunnels**—Carl Wenzinger presented a talk, "The Wind Tunnel in Relation to Aircraft Design," wherein he spoke of special refrigerated tunnels now available in which icing problems can be studied and tests made under different icing conditions.

Two sound and color N.A.C.A. films, *Ames Aeronautical Laboratory* and *Pilotless Aircraft Research* were shown.

Los Angeles Section

E. P. Hartman. *Secretary*

Approximately 200 persons were present at a combined business and technical meeting held November 18 at which Willis M. Hawkins, 1948 Chairman, presided.

Results of the election of officers for 1949 were announced by Mr. Hawkins as follows: Chairman, Joe Barfoot; Vice-Chairman, J. Duffendack; Secretary, E. P. Hartman; Treasurer, W. L. Howland; Member of Area Council Nominating Committee, Willis M. Hawkins.

▸ **Building Progress**—The Chairman made a statement concerning construction progress on the Section's new building, saying that the foundations had been poured, that the framing of the first floor was under way,

(*Continued on page 70*)

News of Members

Clarence M. Belinn, President, Los Angeles Airways, Inc., commercial helicopter line, has been made an Honorary Fellow of the American Helicopter Society.

Dr. Bruno A. Boley left Brooklyn Polytech to join Goodyear Aircraft Corporation as Engineer Specialist last November.

Charles O. Cary, Special Assistant to John N. Brown, Assistant Secretary of Navy for Air, has been named Executive Secretary of the Air Coordinating Committee to succeed John Sherman, who resigned.

Gibson A. Cederborg, formerly a Mechanical Engineer at Langley Field, Va., N.A.C.A., is now a Test Engineer with Westinghouse Electric Corporation doing gas-turbine work.

George J. Clingman is with the Indiana Aeronautics Committee as Director, Mobile Air Education Unit.

Frank A. Culen has been appointed Assistant Treasurer of the Jensen Helicopter Company, Inc.

Hunt Davis, Division Head, Aerodynamics Division, Research & Development Department, Elliott Company, Jeannette, Pa., received the American Society of Mechanical Engineer's Junior Award for a paper submitted by a junior member. His paper was "A Method of Correlating Axial Flow Compressor Cascade Data."

Michael Dubey, former graduate student at M.I.T., is now Test Engineer at Ranger Aircraft Engines Division, Fairchild Engine & Airplane Corporation, Farmingdale, L.I.

John C. Ford is in the Lone Star State with Chance Vought Aircraft at Dallas where he is an Engineer. He moved from Milford, Conn., when Chance Vought transferred operations to Texas.

Earl W. Gault, formerly with Curtiss-Wright (Columbus), is now with Goodyear Aircraft Corporation, Akron.

Joseph T. Geuting, Jr., Manager of the Personal Aircraft Council, A.I.A., announced that ten companies shipped 465 personal aircraft during October. Total dollar value was $2,097,000 figured at manufacturers net billing price and included 311 four-place and 154 two-place planes. Figure represents a decline from September shipments by twelve companies totaling 575 aircraft valued at $2,460,000.

Charles J. Gilbert is Flight Test Engineer with Northrop Aircraft, Inc.

Charles L. Gruenberg is at Boeing Airplane Company (Wichita).

Squadron/Leader Douglas H. Grundy, who has been much on the move the past few years, finally received the I.A.S.'s battered questionnaire that followed him round the world. He reports he is an Engineer Officer with the Royal Air Force, a post he's held since 1942. Sqd./Ldr. Grundy is an A.F.R.Ae.S.

Joseph M. Hample, formerly with Curtiss-Wright Corporation, is now at Wright Field, Dayton, working for the Government as Research & Development Engineer.

J. A. Harper, reported to be with Chance Vought Aircraft, is instead employed by N.A.C.A., Langley Field Laboratory, as an Engineer Test Pilot.

K. Irbitis emigrated recently from Germany to Canada where he is now employed at Otaco Ltd., Orillia, Ontario, as a Design Engineer.

W. J. Jakimiuk has transferred from The de Havilland Aircraft (Canada) Ltd. to The de Havilland Aircraft Company Ltd., Hatfield Aerodrome, Herts, England.

Thomas W. Jarrett, former Senior Mechanical Engineer at Packard Motor Car Company, is now Mechanical Engineer for The Electric Auto-Lite Company.

Subramania Krishnan is a Technical Observer at American Airlines, Inc.

James R. Neff moved from Junction, Tex., to Seattle, where he is a Junior Engineer, Class B, at Boeing Airplane Company.

Harold Oaklander, former Development Aerojet Engineering Corporation, is now associated with the engineering firm of O'Brien & Oaklander as Managing Director.

James E. O'Neill is with the Packard Motor Car Company, Toledo, Ohio, having left M.I.T. where he was Research Assistant, Division of Industrial Cooperation.

H. O. Pierce, former Flight Engineer with Flying Tiger Lines, Burbank, is now with Trans World Airlines, International

(*Continued on page 76*)

C-W BOARD CHAIRMAN

Guy W. Vaughan, leading figure in the aeronautical manufacturing field for more than 25 years, stepped down from the office of President, Curtiss-Wright Corporation, and of Wright Aeronautical Corporation, on December 13. He was elected Chairman of the Board and retains the office of Chairman of the Board of Wright Aeronautical. William C. Jordan, Vice-President and General Manager of Wright Aeronautical, was elected President in Mr. Vaughan's place.

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I.A.S. Travel-Log

It is axiomatic that the real strength of any professional society lies in its local section activities. Unless there is strong local interest, backed up by a willingness of the membership on-the-spot to pitch in wholeheartedly to promote worth-while programs for their own areas, no amount of "priming" or forcing by a national organization can guarantee success.

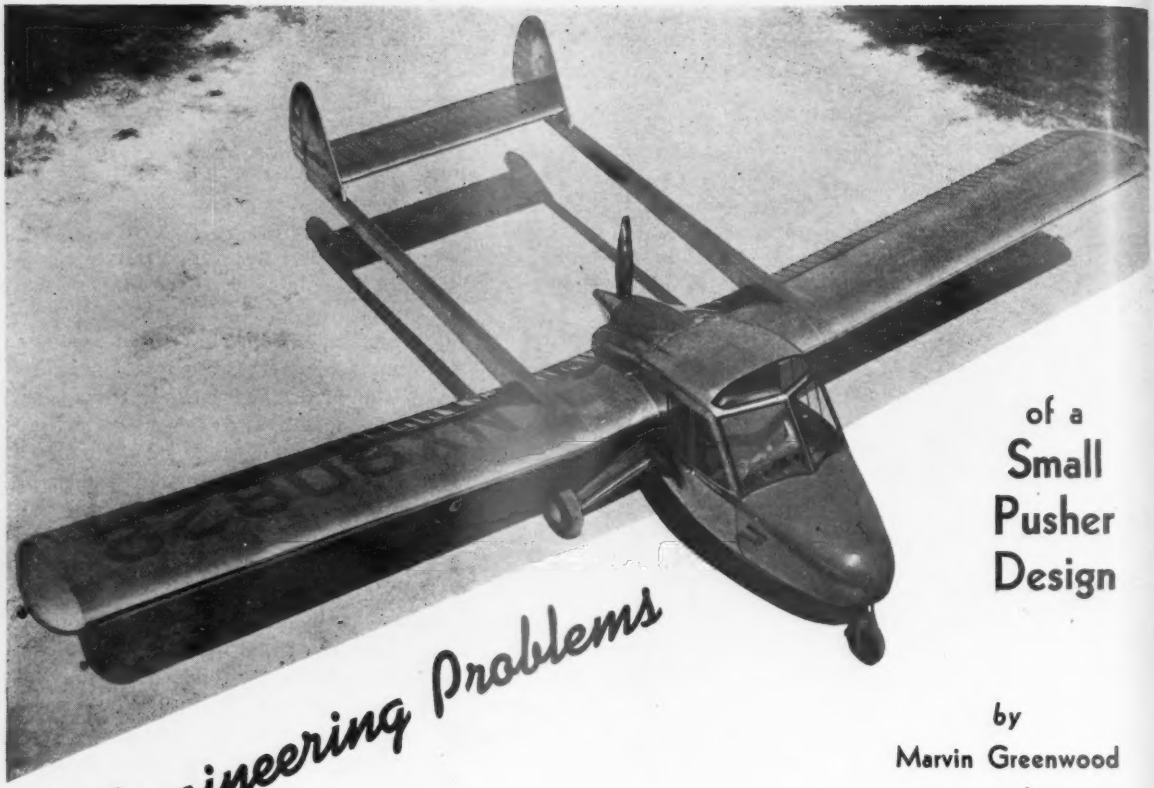
During the Fall of 1948 the officers of the Institute have been spending a considerable portion of their time in travel. We have been attending Section meetings from Coast to Coast and conferring with Section officers regarding plans and programs for the future. Before summer of 1949 we hope to have made personal contact with every I.A.S. Section in all parts of the United States and Canada. In this way we are doing our best to discover the needs of all local activities and the means whereby the national headquarters staff can serve them most effectively.

The results of our travels so far have been most encouraging. Not only are new Sections coming into being (Chicago, Columbus, and Ottawa have been activated in the past 3 months), but the older organizations all over the country are in excellent condition and are doing a real job in servicing their membership. Two months ago in these pages we mentioned the large number of regional meetings that have been held during the past year. After looking over the programs for many of these, it is obvious that the *quality* of such meetings is also on the up-grade. More and more of our older members appear to be willing to pass along something of their wisdom and experience to younger engineers through the medium of I.A.S. papers read before local meetings. In that way they are serving well both the Institute and the organizations they themselves represent.

As would be expected, great interest now exists in the two areas where buildings are now under construction—Los Angeles and San Diego. We met recently with the various committees in charge in both cities and also inspected the construction projects with the architects and the contractors. Nothing short of the highest commendation can be given for the manner in which these jobs are being handled. The local committees are working intelligently and hard—devoting many hours of their own time—to make certain that we get exactly what we want in both facilities and that the funds that have been provided for the purpose by the industry we serve are being spent most effectively. When these two buildings are dedicated early in the summer of 1949, every I.A.S. member will have reason to be proud of the job that has been accomplished by our members in the two western cities.

But, as we have said before, the acquisition of physical plants is not the measure of I.A.S. activities. The people in Seattle and Wichita, and Boston and Toronto, and in all of the rest of our 19 sections are building as solidly for the Institute as the people in Los Angeles and in San Diego. In the long run, it is not brick and steel that make up this organization—it is men—the I.A.S. membership. Every single activity, both local and national, must be directed toward but one goal—Service to our members.

S. P. J.



Engineering Problems of a Small Pusher Design

by
Marvin Greenwood
and
Lomis Slaughter, Jr.*

Introduction

THE ADVANTAGES OF A PUSHER—automobile-easy entrance and egress, excellent vision, quietness, etc.—have been recognized for a long time, yet few successful aircraft of this type have been developed. Many designers have purposely avoided the pusher because of the many unknown problems that might be encountered with it, just as the now conventional low-wing arrangement was avoided before sufficient research data were available.

The pusher does have problems of its own, but all are capable of solution. A few of the more impotrant ones are: (1) Wing-body interference; (2) balance; (3) cooling; (4) soundproofing; (5) unconventional structure.

Although the time required for the development of a pusher is undoubtedly greater than for a more conventional design, the inherent advantages of such an airplane should contribute much to the enjoyment of personal flying.

General Description

The Anderson, Greenwood 14 is a two-place, all-metal pusher. It is powered with a Continental C-90, 90-hp. air-cooled engine. The fixed tricycle landing gear has a long (12-in.) stroke and the nose gear is steerable through the wheel-type aileron control. The tail is carried on twin booms that attach to the wing center section.

Passengers are seated forward of the wing leading edge in a 44-in. wide cabin. Baggage and fuel are located near the center of gravity of the airplane. Baggage is carried in a compartment aft of the seat and below the wing. Fuel is housed in a 23-gal. compartment integral with the nose of the wing center section.

The power plant is located just aft of the center section monospar and is connected through a short spacer to the pusher propeller. Cooling air is ducted from just below the wing leading edge to the engine and exhausts from the engine compartment directly into the propeller.

Design Considerations

In present-day airplanes vision over the front is limited by the engine, and because of this the instrument panel is brought almost up to this line of sight. Some pushers have been built with a normal instrument panel height and vision was little better than that from the better tractor airplanes.

If really good vision is to be had, the instrument panel must be lowered, and unless roominess is sacri-

* Vice-President—Engineering, and Chief Engineer, respectively, of Anderson, Greenwood & Co., Houston, Tex.

ficed, it must be reduced in depth. In larger airplanes with more complicated instrumentation, this reduction may present a problem, but, if careful layout is used, a satisfactory solution may be obtained for small personal aircraft.

Lowering the instrument panel does increase the area of the windshield and tends to increase the drag slightly, but the larger windshield serves a useful purpose, and the slight increase in drag can be offset by attention to some of the other aerodynamic details.

Vision to the rear is also desirable and the shoulder-high position of the wing was chosen for this. In the 14 only a small area is blocked by the wing, and this can be cleared by shifting the head position.

The wing of Model 14 is somewhat unorthodox. The aspect ratio, 9.6, is probably the highest that has yet been used on a small personal airplane. Reasons for this wing design might prove interesting.

The first requirement was for a high span to increase ceiling and rate of climb and decrease speed for maximum rate of climb. The small area was chosen because gust loads are inversely proportional to wing loading and comfort at cruising speed could be improved. The smaller wing area decreases drag and improves cruising performance. In addition, it results in a lower wing weight. Wing flaps are employed so that the smaller area does not result in decreased low-speed performance. A relatively thick airfoil was selected because of structural weight considerations and because of improved stalling characteristics.

The original flaps designed for the 14 were double-opening split flaps (Fig. 1). Their purpose was to minimize the change in trim due to raising and lowering flaps. Later, single-opening plain flaps were tried, and practically no difference could be detected as against the double flaps. No change of trim was noticeable with either set of flaps.

Problems Connected with Pusher Design

Wing-Body Interference

Unless a high-wing configuration is used, wing-body interference becomes a major consideration in a pusher design. The stumbling block in many pusher developments is in attaining a reasonably high power-off maximum lift coefficient. A low-wing arrangement often proves disastrous in this respect, particularly if the converging body is terminated in the vicinity of the wing trailing edge; the combined adverse pressure gradients near the trailing edges prove too much of a barrier, and early separation is almost a certainty at higher angles of attack.

This situation was present to a lesser degree in early tractor low-wing arrangements, and many failures resulted before the expanding fillet was developed to remedy the situation. The expanding fillet has been tried on several low-wing pushers, but, because of the adverse conditions, it is doubtful if much improvement was noted. If a long extension shaft is used so that the body has less convergence and terminates somewhat aft of the wing, the use of an expanding fillet could conceivably cure completely the body-wing interference troubles.

Power tends to decrease the unfavorable pressure gradient of the wing-body intersection and to prevent separation, so that this is not a problem at the lower cruising lift coefficients. The favorable effect of power is absent, however, in landing when the largest possible lift coefficient is needed.

The wing-body arrangement in the Anderson, Greenwood 14 avoids the difficulties of a converging body in the vicinity of the upper wing surface. The only part of the body projecting above the wing is the part that houses the flat engine, and convergence is kept to a minimum. Below the wing, the body is highly tapered and separation might again become a problem on the lower surface of the wing at low lift coefficients (corresponding to cruise and high speed flight) were it not for the favorable effect of power.

Actually, at 100 m.p.h. with power off, there is a small region of separation at the body-wing juncture near the trailing edge. Tuft observations of this were made with a mirror attached to the lower surface of the wing. The application of power cleans up the flow completely. At the higher lift coefficients the flow is smooth with or without power. The cooling air intake ducts help fillet the wing-body intersection beneath the wing.

In addition to the precautions mentioned above, an airfoil was selected (NACA 4418) which is least susceptible to wing-body interference troubles.

A high-wing configuration could have been used for the 14, but vision to the rear would not have been nearly so satisfactory as with the semihigh-wing configuration used.

In spite of the precautions taken on the 14, the maximum lift coefficient is dependent upon the smoothness of the wing-body intersection and upon the smoothness

Fig. 1. Double-opening split flaps were originally designed for the Anderson, Greenwood 14 to minimize change in trim due to flap operation. Landing gears are long-stroke, oil-spring type; the main legs are X4130 steel welded into a box form and heat-treated. The nose cylinder is attached to nose-wheel fork (a T220 aluminum sand casting) and passes through two oilite bearings held in nose gear pickup casting. Cylinder also rotates in these bearings as gear is steered.

of the body-wing intersection. As originally flown, the stalling speed of the 14 was approximately 7 m.p.h. faster than the improved design.

Stalling speed and stall progression are now considered satisfactory. The stall begins at the body-wing intersection and spreads outward to the wing booms. The outer portion of the wings stall only at extremely high angles of attack.

Balance

The problem of balance is an important one in the case of the pusher. The center of gravity still has the same relation to the wing position as in the tractor, but that is about as far as the similarity goes. The location of the major weight items—structure, useful load, and power plant—are completely new.

Let us first consider the useful load items. Their location is now forward of the airplane center of gravity. So that the center of gravity does not vary too much, these items were placed as near to the weight empty c.g. as was possible. The exception to this is the weight of the pilot, which, for flight purposes, was treated the same as a weight empty item; he will be in the airplane whenever it is in flight. Location of the useful load items near the weight empty c.g. is good insofar as the center of gravity shift is concerned, but, in order to obtain the correct balance with minimum useful load, it is necessary for the weight empty c.g. to be as far forward as possible.

The major item in the weight empty which is subject to design movement is the power plant, and it was located as far forward as possible, immediately aft of the main wing spar. A further movement forward would have involved moving the wing, which would defeat the purpose of providing a forward position of the center of gravity with relation to the wing. The short chord of the wing allowed a propeller to be attached directly to the engine through a short spacer with the engine in this forward location. The spacer used on the 14 is approximately 3 in. long and is a glorified aluminum washer. This installation has proved completely satisfactory in over 200 hours of flight testing.

The position of the center of gravity with the useful load out is also of importance, in that, since the useful load is all forward of the center of gravity, its removal shifts the center of gravity decidedly aft. Unless careful consideration is given to this problem, it might result in a shift aft of the main wheels and cause the airplane to sit on its tail when empty.

The balance as worked out for the 14 is from 16 per cent to 26 per cent of the mean aerodynamic chord in flight, and a weight empty position is such that there is a load of 40 lbs. on the nose gear. The load on the nose gear increases to 200 lbs. at full gross load. The center of gravity shift in the flight conditions is a little misleading as given above because of the short mean aerodynamic chord. Actually, the shift is approximately 4.5 in.

Cooling

Another problem critical to the pusher is power-plant cooling. This is by no means a simple one, and, because of its complexity, it will be discussed only briefly in this article. A cooling fan could have been used, but the increased expense and complication ruled it out.

The problem of ground cooling with the propeller is the reverse of that in a tractor. In a tractor, the propeller directly forces the air through the system, while in the 14 the low-pressure area ahead of the propeller is used to induce the cooling airflow. In order to accomplish this the cooling exit area was located in the immediate vicinity of the propeller. To date no cooling troubles have been encountered during normal ground operations.

Cooling air intake ducts are located below the leading edge of the wing. This location has given excellent results under all flight conditions. Cooling air flows from the ducts into the lower engine and accessory compartment, upward through the cylinder baffles, and then to the exit areas in front of the propeller.

Soundproofing

The problem of noise in a pusher is one that is generally misunderstood. The common misconception is that with a pusher engine the noise is "left behind." This is undoubtedly true at speeds above the velocity of sound, but at the current speeds of small personal airplanes this is a minor influence.

For example, assume a cruising speed of 100 m.p.h. The ear of the occupant is traveling away from the noise source at this same speed. At sea level, the noise is traveling toward the ear at 760 m.p.h. This means that the intensity of the noise heard is the same as would be heard in the airplane were it motionless and the occupant was one-seventh farther away from the noise source. Passengers in a pusher are usually located nearer to the noise source than in a tractor, so little reduction in noise should be expected at speeds of 100 to 200 m.p.h.

The big advantage of the pusher is that adequate soundproofing can be installed between the noise source and the occupants. This is not possible in the tractor arrangement because of the necessity of windows between the noise source and occupants.

Much of the soundproofing in the pusher is obtained without additional cost, since upholstered seats are extremely effective in absorbing sound and additional soundproofing need be added only in areas not protected by the seats. For the same weight of soundproofing material the pusher normally should be substantially quieter.

Unconventional Structure

The large field of vision, forward and down, possible in the pusher design is not compromised in the 14 by an overly conventional shaping of the forward fuselage or by excessive width in the window corner posts. It

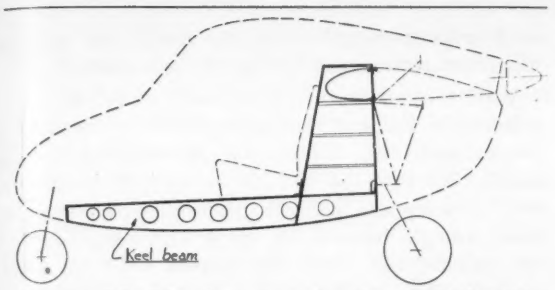


FIG. 2. A keel box beam is employed as the load-carrying member in the Model 14 body as shown in this structural diagram. Completely below the floor level, it permits a full-sized low level door in body side and large front and side windows with narrow, nonstructural corner posts, allowing convenient entrance and egress, as well as a large field of vision.

is possible to have convenient entrance and egress with the passenger cab close to the ground, forward of the wing, and unendangered by the propeller. High structural body sides are not allowed to detract from this convenience.

These demands on the structural design, that vision and entrance be excellent, are met in Model 14 by employing a keel beam as the load-carrying member forward of the seat (Fig. 2).

Nose-gear loads are the major loads in the forward keel beam, since there are no large masses forward of the passengers. The keel beam is reacted horizontally through the baggage floor, and vertically between an open bulkhead in the plane of the seatback. The shear connections between forward and rear bulkheads are the body side skins in this region, the baggage floor, and the wing leading-edge bottom surface.

The wheels are well back under the engine section. Part of this distance back from the nearest convenient structural pickup has been covered by "sweeping" the landing-gear legs back from the trunnions. In order to avoid the weight penalty of cantilever trunnions, a rear support point has been incorporated into a welded tube structure, which also comprises the engine mount.

Similar rear trunnion point supports are also incorporated in this tube structure for the oil-spring shock absorbers. The forward trunnion support points for landing-gear legs and oil-spring units are on the diaphragm bulkhead. Since this same bulkhead incorporates the engine mount pickups and the main spar wing pickup points, it can be seen that the 14 is structurally rather short-coupled. Engine mass loads are transferred through the engine mount to the landing gear during landing and to the wing spar in flight. In flight, engine inertia couple loads go through the bulkheads, through the body skin between the bulkheads, and into the wing.

The engine location, chosen to balance the airplane and to give the best chance of avoiding separation difficulties, places the engine in space normally reserved for wing structure. The structural problem of the wing in this region is to carry through the shear, bending, and torsion loads in the relatively small wing cross-section forward of the quarter chord. It has proved possible to carry the wing trailing edge through the engine section as a tension member, which helps greatly in carrying the forward wing bending from high angle of attack flight conditions.

The wing center section of Model 14 (Fig. 3) has a monospar at approximately 27 per cent chord and a light auxiliary rear spar. The spar in the center section portion of the wing is a 24ST extrusion with caps and web extruded as one piece. This has the advantages of simplicity and low cost. Simplicity and elimination of rivets are particularly important in this case, since this spar web also forms the back side of the structurally integral fuel tank.

The torsion and tank section, in the center wing region, is the "D" formed by the spar and the leading-edge skin. This "D" section has been kept as free of internal projections as possible in case a fuel cell is ever used. Fore-and-aft corrugations in an internal doubler sheet, which have been used to bring the shear strength of the skin up to the required value, start just inboard of the tank end ribs and run to the body torsion panels. The corrugations are not required inboard of these body panels, since the torsional shear is taken in the panels which, in effect, are external wing ribs.

The leading-edge torsion load is taken out of the leading edge by the end ribs, which are just forward of the wing boom connections at the outer end of the center section. These ribs have shear web, as well as top and bottom cap continuity with the boom attachment boxes that are at either end of the center section behind the main spar. These boom attachment boxes also serve as outer ribs of the center section. The boxes are made up of two parallel vertical planes and two parallel horizontal planes, which are extensions of the planes of the booms. Each boom box provides four forged fittings at the trailing edge to which the booms attach. A bulkhead in the boom box is attached to the center section rear spar and to the rear spar of the outer wing. At the wing main spar the boom boxes are secured top and bottom by the bolts that hold the wing joint terminal fittings onto the main spar extrusion.

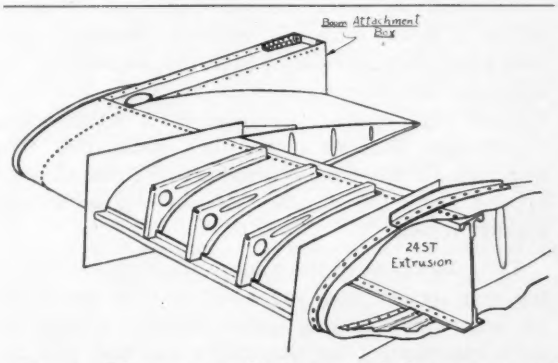


FIG. 3. Wing center section is composed of a monospar and auxiliary rear spar. The spar in the center portion of the wing is a 24ST extrusion with caps and web extruded as one piece. This has the advantages of simplicity and low cost. Simplicity and elimination of rivets are important in this case, since this spar web also forms the aft side of the structurally integral fuel tank.

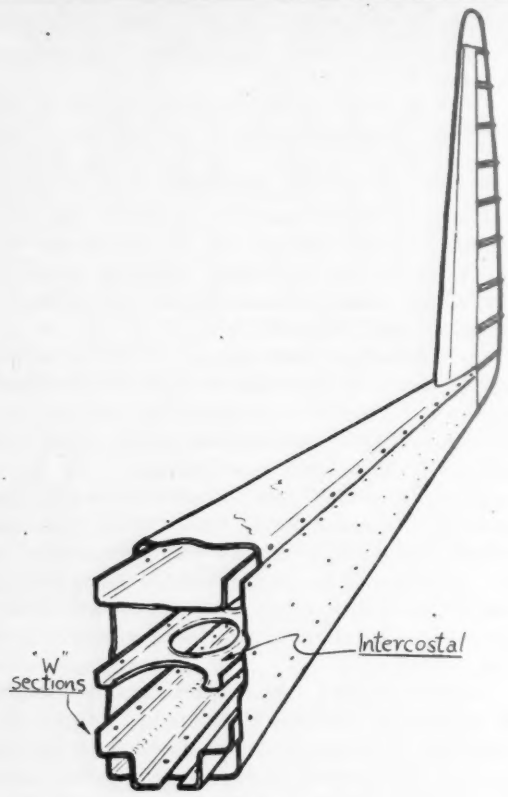


FIG. 4. Boom structure consists of a top pan, sides and bottom made from one bent-up sheet, "W" sections added at bottom corners to increase compression strength of boom, and an intercostal midway between top pan and bottom to increase buckling strength of sides.

The ribs at the body side are fire resistant, and, because of the engine well discontinuity, they have been tied into the body torsion panel to allow the transfer of load from the body panel to the rear torsion panel of the wing.

The stiffening in the intraspar portion of the center section is in the form of a spanwise intercostal spar, used to avoid the contoured parts that members in the chordwise direction would have required. For aerodynamic reasons, the trailing edge of the center section is internally stiffened rather than corrugated. The large well-rounded trailing edge has been found to stand up well under the vibration stresses imposed by the nearby propeller.

The attachment of the wing to the body consists of the body torsion panel and a bolt on each side of the airplane running in a for-and-aft direction through an angle extension of the diaphragm bulkhead and the web of the main spar. The spar is built up by a pad to increase the bearing loads where the bolt passes through. The tank is sealed around the bolt by a beveled washer trapping an "O" ring against the bolt. The body torsion panel acts as a wing rib putting vertical load in the wing leading edge and maintaining the wing cross section against "parallelogramming."

Vertical loads from wing to body go through spar bolts to the bulkhead and through rivets between the vertical part of the leading edge and the body torsion panel. Horizontal shear loads are carried through the body torsion panel, and these loads require considerable shear strength between the upper and lower edges of the torsion panel. This has necessitated fairly thick shear doublers in the small neck of the torsion panel opposite the wing leading edge.

The vertical sides and flush-to-wing bottom surfaces of the tail booms (Fig. 4) were dictated by the aerodynamics of the wing boom intersection which called for an extremely clean surface detail. At the forward end of the boom two bulkheads and several shear doublers put the loads into four forged fittings that mate with similar fittings in the boom attachment boxes. The front and rear spars of the vertical tail form the bulkheads in the rear of the boom that load the boom with the horizontal and vertical tail loads. A fairing cover to the top pan provides aerodynamic cleanness and accessibility to the tail cable controls and allows a beam design with good accessibility for fabrication.

The horizontal stabilizer is composed of two spars, two end ribs, one rib on the airplane centerline, and beaded skin. The beads run in a for-and-aft direction and increase the ability of the 0.016 skin to carry the local air loads. Three ribs has proved a sufficient number to make the spars work together.

All the movable surfaces—ailerons, elevators, flaps, and rudder—are similar to each other in construction, and all are attached to their respective fixed surfaces by short lengths of piano hinge. The typical construction is a spar of channel or "Z" form, with corrugated skins (4-in. spaced, $^1/_4$-in. deep, "tent" corrugation), an inserted 0.040 trailing edge strip, and end ribs with operating horns attached. It has proved desirable to reduce the hinge deflections by a clip that triangulates from the outer edge of the flange under the hinge to the flange web intersection across the spar. This stiffening reduces control system deflections and is a safeguard against fatigue failure in this area.

Like the center section, the outer wing is monospar with an auxiliary spar (Fig. 5). A torsion cell is formed by the two spars and top and bottom skins. A second "D" torsion cell is formed forward of the main spar by the leading-edge skin and is stiffened against buckling by leading-edge ribs and spanwise intercostal spars.

At the joint between the center section and the outer wing the torsion load from the two wing cells is collected in a rib with a reinforced cap strip. The torsion load is then reacted against the tail load through the main spar terminal and the rear spar terminal, both of which tie into the center section boom attachment box.

The main and auxiliary spars are connected by four main ribs in the outer panel, though each interrib skin

area is broken up into three smaller panels by ribwise channel stiffeners. These stiffeners, as well as the ribs, are gusseted to the front and rear spars to take the corner loads from the panels when the light gage skin buckles under load.

The 0.016 gage skin from the main to the auxiliary spar is one continuous sheet from the inboard to the outboard of the panel. The leading-edge skin is also continuous. The outer wing has no trailing edge, since all of the area aft of the auxiliary spar is taken up by movable surfaces.

The outer wing vertical loads come through fittings from the main spar of the outer wing to the main spar of the center section. These fittings are heat-treated steel slabs of simple design. One fitting design serves 16 times per airplane, two upper and two lower on outer wing and center section, left and right wings. At the spar end, in addition to the steel fittings just mentioned, there is an aluminum column bar from the upper main bolt hole to the lower and tied into the shear web of the outer wing spar. The function of this member is to take bending out of the terminals and to pick up the outer spar shear load. The bolts connecting the wings are in a fore-and-aft direction in holes reamed on assembly through the wing fittings. The outer wing and center section rear spars are bolted together through a fitting to carry the tension and torsion loads.

An interesting design detail is the outer wing spar. This member is made up of extruded caps, tapered by machining and riveted to a corrugated web. The corrugations, spaced at 4 in., serve as spar web stiffeners. While low cost by elimination of parts and rivets is possibly the chief advantage of this web, it has also turned out to have a low weight. A series of tests were necessary to accumulate enough information to design this shear web.

The wing tip is plastic-impregnated fiberglas and is attached to the flange of the tip rib in the outer panel by screws into Tinnerman nuts.

The landing gear of Model 14 is designed to land the airplane safely from a rate of descent of 15 ft. per sec. (900 ft. per min.), which is considerably in excess of C.A.A. requirements. It was originally conceived as

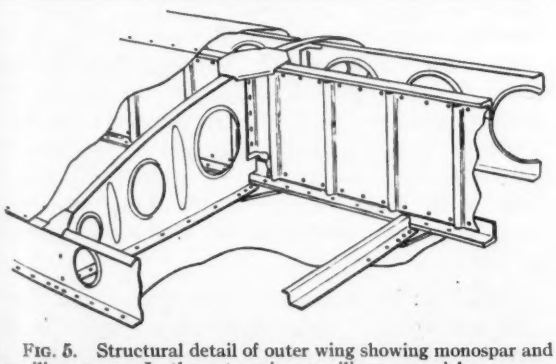


FIG. 5. Structural detail of outer wing showing monospar and auxiliary spar. In the outer wing, auxiliary spar picks up movable surfaces and also carries local air loads to four main ribs, which in turn carry loads to main spar.

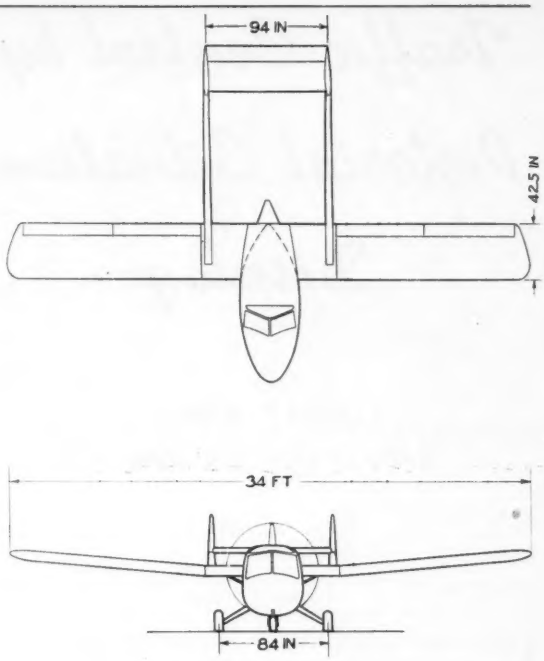


FIG. 6. Model 14 plan view.

an added factor of safety but, in addition, has worked out to give a pleasant landing.

With the extreme vision over the nose, a normal landing gives the visual sensation of rapid descent, and with flaps down the approach is rather steep. The pleasant, gentle nature of ground contact comes as a surprise. The passenger has the feeling that the airplane has merely been turned into a more horizontal path.

The control system is a conventional cable type with dual control wheels. Rudder pedals have been provided on the left-hand side for the pilot who wants to achieve perfect turns, but there are none on the right because the airplane can be very nicely handled without any and because their absence gives the passenger more leg room. The elevator tab is a hand-operated crank. The brakes are hydraulic and are foot-operated from a pedal on the floor, although some thought has been given to a combination brake-throttle, which may be included before certification is complete.

The engine section is of interest as a distinctly pusher problem, though it has much in common with a submerged installation. Underwing ducts of triangular cross section pick up air at the wing-body intersection near the wing leading edge. The inducted air is carried along to a point aft of the main bulkhead, flows through a pressure-tight compartment under the engine, up through the engine baffles, and out on top of the engine. The air exists through passages just forward of the propeller. This relation to the propeller is counted on to draw air through the system for ground cooling, eliminating the need for a blower.

(*Continued on page 33*)

Traffic Control by Pictorial Situation Display

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Radio Corporation of America

Introduction

It is well recognized that improved methods of air traffic control are needed today and that in the future this subject will increase in importance and complexity as traffic becomes more dense. The overall problem is one of the most difficult facing the engineer. In three-dimensional air space filled with fog, numerous aircraft having different speed and maneuverability characteristics and different destinations must be controlled in an economical and safe manner.

Some of the factors that contribute to the complexity of the problem are: Most aircraft cannot stop in the air; some go slowly and cannot go fast, others go fast and cannot go slowly; the problem is three-dimensional; unpredicted wind variations affect the speed and location of each aircraft; each aircraft must make a normal landing within a safe time limit; spacings between landings should not be more than about $1^1/_2$ min., meaning that an aircraft 40 sec. off schedule is seriously out of place; the system must serve all types of aircraft including the military, it must be capable of integration with existing facilities in an evolutionary rather than revolutionary manner; and it must be usable *by mere humans such as pilots*.

Many helpful components have been developed including aural ranges, ADF's, omni-ranges, ILS, GCA, and others. More recent developments, some of them intended to approach the problem for the first time from the overall systems point of view, include Teleran, Navar, Lanac, GRS block, and Tricon. Rather thorough studies of some of the broad aspects of traffic control were made by several organizations, notably Air Transport Association,[1] Airborne Instruments Laboratory,[2] Civil Aeronautics Administration, and Radio Corporation of America.[3,6,7]

The results of these systems developments and studies formed part of the background for the deliberations of Committee SC-31 of the Radio Technical Commission for Aeronautics. In 1948, by action of the Secretary of Commerce and the Secretary of Defense, an Air Navigation Development Board was established for the purpose of planning and sponsoring the development of a "common national system of air navigation and traffic control." This Board is permanent. It is using the SC-31 report as its guide, making such deviations as seem desirable.

The recommendations of SC-31 are lengthy and will not be reviewed here. One of its specifications is that there be ground radar equipment that obtains its responses from altitude coded air-borne transponders. This radar is to be the chief source of data for traffic control and is to produce a "pictorial situation display" for use on the ground and for transmission to each aircraft. It is specified that this display be developed for all types of aircraft that fly on instruments and be used *in all phases of traffic control* (initial approach, final approach, movement on the surface of the ground).

This is an important new concept in aircraft flight. The utilization of pictorial situation display to the extent specified is presently found in Teleran.[4] In providing each pilot with a television-like picture, some serious aspects of the aircraft instrumentation

* Loren F. Jones, pilot and engineer for 21 years, originator of Teleran, is manager of research and development sales. As a leading proponent of pictorial display, he is largely responsible for the present high interest in this subject. The new traffic control ideas disclosed in the article have been tested by Link trainer flights employing pictorial presentation.

problem are resolved.* A typical installation with 7-in. picture is sketched in Fig. 1. There is no reason to regard the process of interpreting multitudinous dials, pointers, scales, maps, aural ranges, verbal instructions, and signals, as being natural to a human being, but there is good reason to give man information in the form in which he has easily and conveniently acquired it for thousands of years—namely, by vision of the pictorial type. A pilot thinks of his aircraft as a spot moving on a map. Uniquely, the television-like pictorial display does just that; it shows the pilot a special map of the area, the location of all aircraft at or near his altitude, where each is headed and which is his own, along with diagrammatic traffic control instructions. This important forward step in aviation has been described[4] and will be discussed more fully in a forthcoming paper.[5] Flight tests are currently being conducted with comprehensive experimental equipment. The results are extremely favorable. Nearly 200 pilots have flown by pictorial display in a Teleran Link trainer. Each of the traffic control methods discussed in this paper was flown.

Pictorial Situation Display

The SC-31 plan specifies that traffic control instructions be transmitted to each aircraft by two basic means. One is the so-called private line, a selective circuit to individual aircraft permitting the transmission of specific traffic control data. These data can be used by the pilot for manual flight (for instance, by annunciator signals saying "go 10 m.p.h. faster," "go 15 m.p.h. slower," etc.), or it can directly actuate the throttles and other controls. It is not the purpose of this paper to discuss the use of private-line signals. The second basic method is "pictorial situation display." The pictorial instrument *will give pilots a large quantity of information in diagrammatic or pictorial form*, not only traffic control data but also weather maps and other information. It is the author's contention that the value of pictorial presentation is even today only partly realized and that further flight experience may indicate that the picture itself will constitute the primary flight aid in traffic control.

* The desirability of pictorial presentation was pointed out by Zworykin in 1932. Subsequent developments in ground radar and airborne transponders were necessary before it was possible to devise an integrated, comprehensive, and practical system.

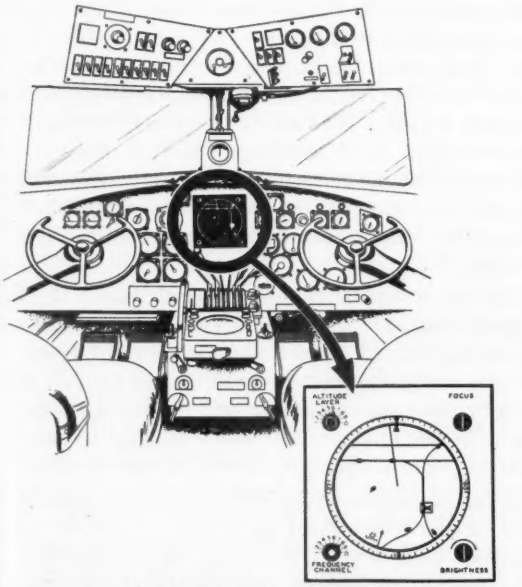

Fig. 1. Television-like pictorial display instrument mounted in cockpit employing 7-in. picture screen. Present apparatus produces picture brightness of 50 lamberts, eliminating the need for a visor. Smaller screens can be developed for use in smaller aircraft.

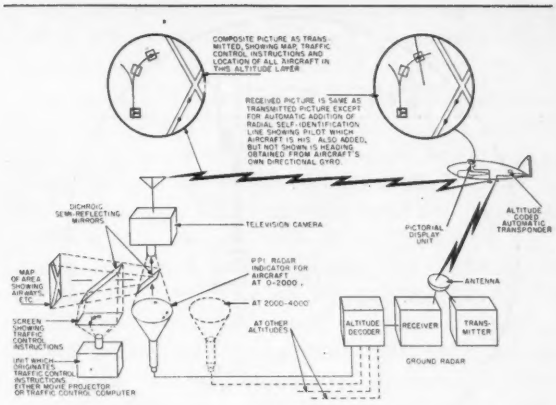
COMPOSITE PICTURE AS TRANSMITTED, SHOWING MAP, TRAFFIC CONTROL INSTRUCTIONS AND LOCATION OF ALL AIRCRAFT IN THIS ALTITUDE LAYER
RECEIVED PICTURE IS SAME AS TRANSMITTED PICTURE EXCEPT FOR AUTOMATIC ADDITION OF RADIAL SELF-IDENTIFICATION LINE SHOWING PILOT WHICH AIRCRAFT IS HIS. ALSO ADDED, BUT NOT SHOWN IS HEADING OBTAINED FROM AIRCRAFT'S OWN DIRECTIONAL GYRO.
DICHROIC SEMI-REFLECTING MIRRORS
TELEVISION CAMERA
PICTORIAL DISPLAY UNIT
ALTITUDE CODED AUTOMATIC TRANSPONDER
ANTENNA
MAP OF AREA SHOWING AIRWAYS, ETC.
PPI RADAR INDICATOR FOR AIRCRAFT AT 0-2000 ,
AT 2000-4000
AT OTHER ALTITUDES
SCREEN SHOWING TRAFFIC CONTROL INSTRUCTIONS
UNIT WHICH SIGNALS TRAFFIC CONTROL INSTRUCTIONS TO PILOT
PROJECTOR OF TRAFFIC CONTROL COMPUTER
ALTITUDE DECODER
RECEIVER
TRANSMITTER
GROUND RADAR

Fig. 2. Essential elements of a pictorial display system. By adding another dichroic mirror, handwritten emergency instructions can be added into the composite picture.

To form a pictorial display by Teleran (the generic term "Teleran" is a composite work from *tele*vision-*r*adar-*a*ir *n*avigation), all information necessary for general navigation, traffic control, collision prevention, landing, and taxiing control is obtained on the ground and is automatically combined into a pictorial display. Altitude segregation is used so that the pictures presented to ground and air-borne personnel concern single altitude layers and are in a form well adapted to human interpretation and action. The composite picture for each altitude layer is produced by combining ground radar information, showing the location of all aircraft, with map information and diagrammatic traffic control displays and other visual data. New air routes are established by the simple expedient of adding new lines to the televised map. The complete television-like composite picture is projected on large screens on the ground and *is transmitted to each aircraft.* Means are provided to constantly show each pilot which of the aircraft in the received television-like picture is his own, The system is illustrated in Fig. 2.

During final approach, the instrument landing situation is presented pictorially to each pilot by means of data obtained from standard GCA equipment. The received picture shows the position of the aircraft with respect to the ideal landing path and airport and with respect to other aircraft on the landing path. Other pictorial data such as weather maps can be readily transmitted over the ground-to-air television link. The

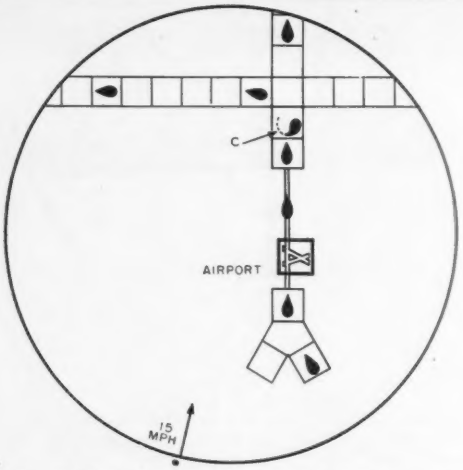

FIG. 3. Typical "fixed block" pictorial display. This television-like display is seen both on the ground and in the cockpit. In addition, the cockpit picture in each aircraft contains a self-identification mark for that particular aircraft. Aircraft in Block C is circling, to hold until the block ahead is vacant. Lettering is added for illustrative purposes and would not appear in actual pictorial display.

pictorial display unit in the aircraft produces a bright, flickerless picture suitable for viewing in normal daylight. Although the present equipment weighs about 100 lbs., further development should result in light, compact equipment suitable for installation in all aircraft down to and including the four-place type.

General Requirements for Traffic Control

Before discussing specific methods of presenting traffic control information pictorially, it is well to review the general requirements for any traffic control system. These are the major ones:

(1) For prevention of collisions and for other safety reasons, each pilot must at all times know by simple and natural indications the location of his own aircraft with respect to (1) his assigned position in the traffic pattern, (2) the final approach path, (3) the airport, and (4) all other aircraft at or near his altitude.

(2) High- and low-speed aircraft must be accommodated without forcing them to operate at a single compromise speed, except possibly when on the final approach.

(3) In view of the complexity of traffic control of the future, control should be accomplished primarily by means of computer devices on the ground, with minimum responsibility placed on ground personnel and even less responsibility on pilots.

(4) For monitoring and emergency reasons, ground personnel should have the same information as pilots.

(5) Each pilot should be enabled to occupy a specific air space, knowing that in so doing he is protected from collision and will land with minimum delay.

(6) Changes in wind velocity should be compensated for with minimum effort on the part of the pilot and preferably without ground-crew action. Change in wind direction necessitating the use of a different runway should require little action on the part of ground crew and should be presented to pilots in a simple and natural manner.

(7) Requirements for take-off are similiar to those listed above for descent and approach, except that the take-off and climb path need not be so long as the approach path.

(8) In the case of scheduled aircraft, identification of each aircraft is necessary so that its progress can be compared to its schedule. In the case of nonscheduled aircraft, identification is not regarded as a basic requirement any more than policemen must identify individual automobiles for automobile traffic control. In practice, however, identification of nonscheduled aircraft may prove to be desirable.

(9) Since safety is increased by consistency and standardization in flight operations, traffic control facilities and procedures should be suitable for identical use whether flight is contact or on instruments.

Several methods for depicting traffic control instructions by pictorial situation display which meet the above requirements will now be proposed, with variations as to the kind of "blocks" used and the types of aircraft controlled. These particular methods are not claimed to be the best, but they serve to illustrate the flexibility, convenience, and potentialities of the pictorial method.

The Fixed Block Picture in the Approach Zone

There are two basic concepts of traffic control: one based on the use of "fixed blocks" as in the case of railroad traffic control, the other based on the use of "moving blocks." In the case of fixed blocks, each block consists of a fixed segment of the airway. As the pilot progresses from block to block he does not enter the block ahead unless a green light (a private-line signal) and his pictorial situation display show that that block is vacant. If an aircraft is in it, he circles in his present block until the block ahead is free. While circling within his block the pictorial display shows him his position within the margins of the block and provides true saftey from collision with other aircraft in adjacent blocks.

Fig. 3 depicts a typical pictorial display for use with the fixed block method. The aircraft in Block C is holding, waiting for the block ahead to become free. In case an unequipped or unauthorized aircraft were to fly into an established airway, the pictorial display would be one means and probably the only means permitting pilots of equipped aircraft to avoid a collision.

Whereas the simple case of Fig. 3 could be flown with ease, actual traffic densities frequently will be much greater. In such cases, it is agreed by virtually all who have studied the problem that a ground located traffic control computing device will be required. Some comments on this device are necessary before proceeding with the discussion.

The Traffic Control Computer

No longer will human brains and posting boards be able to cope continuously and reliably with the traffic situation. Within about 5 years from now, congested areas, such as that of New York, may well have about 100 planes simultaneously subject to traffic control during some hours of the day. At times of peak traffic each runway in use must accommodate a plane about every $1^1/_2$ min., and any aircraft as much as 40 sec. out of place will upset the traffic control situation.

It is generally agreed that a computer must be available which, when any one aircraft arrives at the periphery of the control zone, will take into account the aircraft's speed capabilities, its altitude, its approach path, the wind velocities, and the availability periods for the runway, so that proper instructions or control can be automatically transmitted to each aircraft. These must enable each aircraft to reach the beginning of the final approach (start of glide path) with correct spacing from aircraft ahead and behind.

For an electrical or mechanical computing device to perform this function, its input data must include for each aircraft: altitude, destination, available speed range, identity, and wind velocities. It can take into account average wind velocities in a given area or, with greater accuracy, actual wind velocities at each part of the area and at each individual altitude. Additional studies are presently being conducted[6] to determine the extent to which wind velocities must be taken into account by the automatic computer.

Committee SC-31 recommended that there be two methods of obtaining the location of each aircraft: an air-derived method and a ground-derived method. Since the air-derived information is relayed to the ground, there will be two sets of data on the ground. This permits the automatic traffic control computer continuously to compare these two sets of location data. If an unequipped aircraft strays into the zone of control, its position, of course, does not show up among the air-derived data but does show up among the ground-derived data as received by ground surveillance radar. The computer must automatically recognize this as an emergency and take appropriate action.

The computer can be given a third set of data—namely, the flight plan of each aircraft in the area. Thus an additional function that the computer could perform would be that of constantly analyzing three sets of data: where the air-derived information indicates the aircraft is, where the ground-derived data indicate it is, and where the aircraft planned to be. This rather elegant method would be possible only when each aircraft does file a flight plan (which is fed into the computer, possibly by punch card) and is expected to then either adhere rigidly to the plan or to a series of approved revised plans. There is some question as to whether this degree of elegance will be employed in practice. It would necessitate the automatic transmission of a great deal of data over individual air-ground circuits. It might involve the use of complicated "automatic tracking" radar circuits for each aircraft. It presupposes that aircraft will precisely adhere to rigid flight plans.

In recognition that flexibility rather than rigidity of flight plan would be desirable, the author, in 1946, pointed out the feasibility of providing traffic control means for handling aircraft arriving at the boundary of the control zone with essentially random timing. In 1947 under a contract with RCA, the Franklin Institute conducted studies showing that it would be practical to construct a computer that would safely and expeditiously control aircraft arriving at random.[7] It was not intended that aircraft would enter the control zone completely at random, because this might involve, in the absurd case, arrival of all aircraft for a given airport during 1 hour of the day, with no aircraft during the remaining 23 hours. To prevent resulting oversaturation of airport capacity, some degree of prescheduling is essential. Thus, no aircraft would take off for a given airport without first receiving clearance. The clearance would be an assurance that that aircraft could be accommodated at appoximately its estimated time of arrival. Its actual arrival time might vary considerably from the estimate. Thus, over, say, a 15-min. period, *arrivals would be truly random*.

It is this sort of random arrival timing that can be automatically taken into account by a suitable computer. In this method, each aircraft contacts the ground control center just before entering the control zone and reports its position, speed, and other necesary data. These data are placed in the computer, preferably by pressing keys or buttons. The computer immediately determines whether the aircraft can arrive at the start of the final approach (glide path) with adequate spacings from the next aircraft ahead and behind. In arriving at its answer, the computer takes into account wind conditions, the safe minimum and maximum speed limits for this particular aircraft, the locations and assigned speeds of other aircraft, etc. Unless the airport is operating too near to saturation, essentially every aircraft arriving at the control zone boundary can be accommodated immediately by employing variations in speed during its initial approach through the control zone. The correct speeds are specified by the computer. The entire situation is shown to each pilot by his pictorial situation display. When an aircraft cannot be accommodated, the computer will so designate, and the aircraft will hold for a few minutes outside of the control zone until it can be accommodated.

It is not claimed that this random arrival method is necessarily the best one for controlling so-called scheduled aircraft but rather that it is a possible method deserving further study, a method wherein individual aircraft *can deviate considerably from their schedule as originally filed* yet can be accommodated with little or no delay upon their arrival in the control zone of the terminal airport.

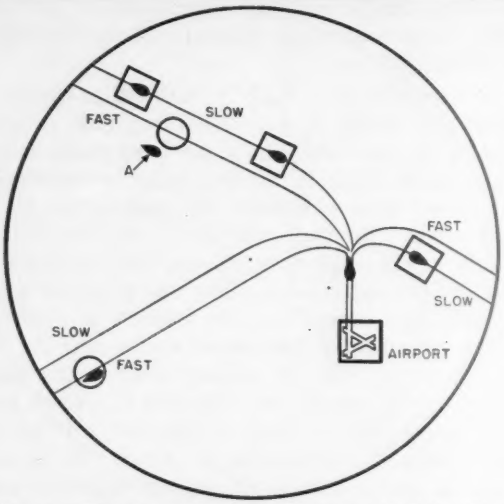

FIG. 4. Typical moving block picture for scheduled aircraft. Circular blocks show scheduled locations for fast planes; rectangular, for slow planes. Pilot A needs to correct his position. Blocks automatically slow down near start of final approach, where they arrive without conflict, their arrival times having been previously checked and accepted by the automatic computer. Take-off paths are not shown.

The flexibility of pictorial display permits its ready adaptation to any method of control—i.e., rigidly scheduled, flexibly scheduled, or nonscheduled. Let us consider typical pictures for each case.

MOVING BLOCKS FOR RIGIDLY SCHEDULED AIRCRAFT

The second general method of traffic control is that employing moving blocks rather than fixed blocks. Whereas blocks at fixed locations are appropriate for railroad trains, which can stop, in the case of aircraft there are some advantages in using blocks that constantly move. Moving blocks were proposed by I. Wolff and P. J. Herbst of RCA Laboratories in 1945, who suggested that symbols be caused to move at constant speed and in straight lines across the pictorial display, each symbol representing an air space for a single aircraft. The "curved path variable speed" moving block methods proposed herein are outgrowths of the earlier suggestions.

First take the case of an aircraft operating under a rigid schedule. The automatic traffic control computer can cause the picture to contain moving circles or rectangles that depict for each aircraft the air space that that aircraft should at each instant be occupying. At the same time each aircraft's actual position as determined by ground radar is shown in the picture, and thus the pilot can readily see whether he is within the area assigned to him—that is, whether he is exactly on schedule and on track. Fig. 4 illustrates a typical picture seen by pilots flying rigidly scheduled aircraft in the moving block system. Circles represent scheduled locations for certain high-speed aircraft; rectangles represent the location for specific lower speed aircraft. The circles and rectangles proceed toward the start of the final approach in a continuous manner, much as though they were projected from "animated" film, their individual motions being in accordance with each aircraft's approved flight plan. The computer can cause the blocks to appropriately and automatically slow down as they near the start of the final approach, thus allowing for the lowering of wheels and flaps.

In this particular illustration, pilot A is not within his assigned area and should get within it. With pictorial display on both the ground and in aircraft, any pilot who is not within his assigned area not only immediately knows this himself but *so do other pilots and so do the traffic control personnel on the ground.* No longer will a pilot think or say that he is one place when he is actually somewhere else.

MOVING BLOCKS FOR FLEXIBLY SCHEDULED AIRCRAFT

As discussed above, it may prove desirable to permit a reasonable degree of flexibility as necessitated by weather variations and other unanticipated factors. In this case, with arrival at the boundary of the control zone having somewhat random timing, the moving block system would again assign individual blocks to individual aircraft, with the important difference that a block would appear for a given aircraft not necessarily when originally scheduled to appear but rather when actually requested by that aircraft. As an example, when the pilot of aircraft B of Fig. 5 is about 5 miles outside of the control zone, he contacts the traffic control center and states that he will be within the zone within 2 min., is on the northwest high-speed approach, and is in a certain type of aircraft. In exactly 2 min. the automatic computer causes a block to appear in the picture as shown in Fig. 5, and the pilot finds himself within the block regardless of whether he is a few minutes ahead of, or behind, his original schedule. The computer then moves the block toward

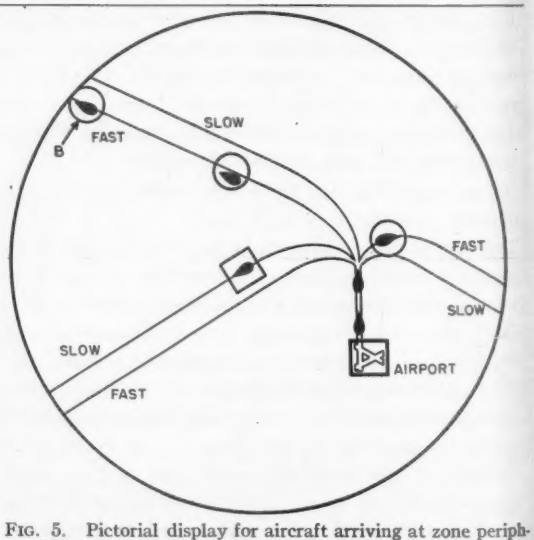

FIG. 5. Pictorial display for aircraft arriving at zone periphery with random timing. If plane B arrives a few minutes ahead of, or behind, its original schedule, its block appears when it actually arrives, not when it was supposed to arrive. Speed of the block is then automatically varied within limits safe for plane B, such that there is no conflict with other blocks.

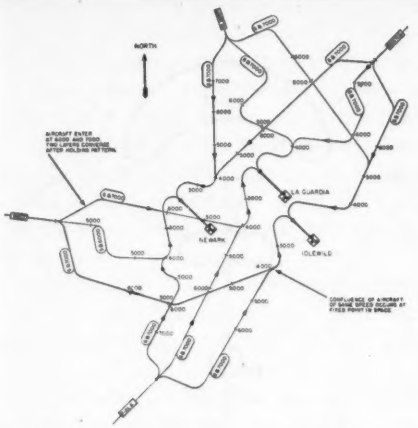
NORTH
LA GUARDIA
IDLEWILD
NE MARK
AIRCRAFT ENTER AT 6000 AND 7000 THE LAYERS CONVERGE AFTER HOLDING PATTERN.
CONFLUENCE OF AIRCRAFT OF SAME SPEED OCCURS AT FIXED POINT IN SPACE.

FIG. 6. Proposed approach paths for New York area (Idlewild, La Guardia, and Newark airports) for medium-speed planes.

the start of the final approach, automatically adjusting the speed of the block (within the safe speed limits of the aircraft) so that the block finally arrives at the start of the final approach with safe spacing from other blocks.

With this method of operation pilots are permitted reasonable flexibility from their schedules yet are landed with minimum delay. In a study by Ewing, Faunce, Marshall, and Smith,[8] a comparison is made between the delays to be expected with moving block as compared to fixed block traffic control. It is shown that delays are somewhat less with the moving block method. Additional factors must, of course, be considered in comparing moving with fixed blocks.

The control of aircraft on take-off paths is not discussed in this paper. The problem is simpler than for approach paths and similar techniques are used. Also not discussed is the selection of specific altitudes for altitude layers, nor is the transition of descending and ascending aircraft from one layer to another discussed. Altitude segregation is employed because it simplifies the overall problem.

Actual approach paths are likely to be more complicated than those illustrated in Figs. 3, 4, and 5. In the most complicated case of all—i.e., New York with its La Guardia, Newark, and Idlewild airports—the study by Ewing, Faunce, Marshall, and Smith[8] shows how fast, medium, and slow aircraft (separated by altitude) can approach from all directions (Boston, Albany, the West, and Philadelphia) to all airports without conflict. When descending in the initial approach, slow and medium aircraft do so at 500 ft. per min., fast aircraft (pressurized cabins) at 750 ft. per min. Altitude separation allows for the necessary crossing of approach paths and provides for all take-off paths. No "stacking" is employed. Pictorial presentation is essential. Details will not be discussed here, but it is of interest to note their proposed approach paths for medium speed planes for southeast wind conditions, as depicted in Fig. 6. Fig. 7 shows the actual picture which might be received by planes in the 4,000- to 7,000-ft. layer, with moving block traffic control.

MOVING BLOCKS FOR NONSCHEDULED AIRCRAFT

Nonscheduled aircraft including executive planes, chartered transports, military aircraft, cargo planes, and others are already much more numerous than scheduled aircraft and are today flying more extensively than are the scheduled aircraft. (The cub-type plane is not considered in this discussion, since it generally is not equipped to fly on instruments.) During the next few years, the problem of providing for tens of thousands of instrument-equipped nonscheduled aircraft will become of great importance. It is likely that aircraft of this type frequently will employ separate airports adequately spaced from airports specifically reserved for scheduled aircraft. In this way one of the most appealing features of flight will not be sacrificed—that is, the ability *to go where one wants to when he wants to go there.* SC-31 recognized this and provided for informal nonscheduled flights in that such operations are not prohibited off of the established airways. Established airways start at certain minimum altitudes and thus can be "crossed" at lower altitudes without notice.

But before the nonscheduled aircraft can fly to a nonscheduled airport with only the simplest kind of advance arrangements, it must be known that there is some means at that airport for the orderly handling under instrument conditions of traffic arriving with essentially random timing. A simple method of doing this, requiring no traffic control computer on the ground, is illustrated in Figs. 8 and 9. The basic concept and direction of motion is shown in Fig. 8. Fig. 9 shows five successive pictorial display scenes spaced about 30 sec. apart. The blocks move *constantly* from top to bottom. In the illustration, one block is shaded to assist the reader in tracing its motion. The blocks actually are reproduced from a closed loop of animated film in the ground transmitter. It will be noted that the center of the blocks moves toward the airport more

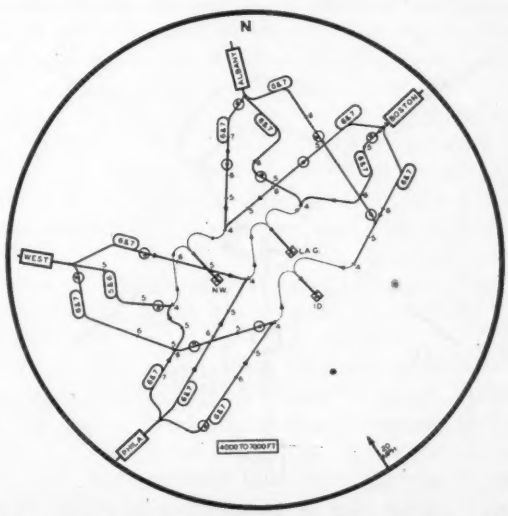

FIG. 7. Picture received by aircraft in 4,000–7,000-ft. layer for New York area, using moving block traffic control.

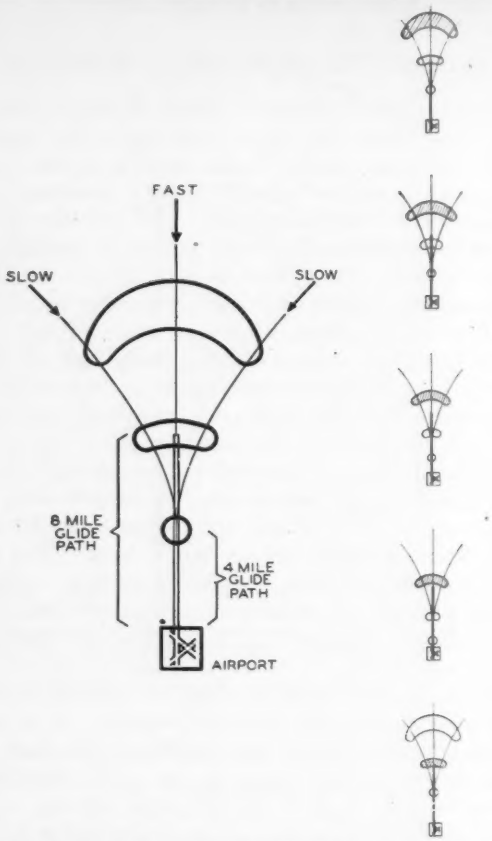

FIG. 8 (*left*). Basic concept of "moving stairway" moving block system for nonscheduled aircraft. Lettering is added for convenience of reader and would not appear in actual pictorial display.

FIG. 9 (*right*). Five successive scenes, spaced about 30 sec. apart, showing moving block motion for nonscheduled aircraft. One block is shaded for convenience of reader.

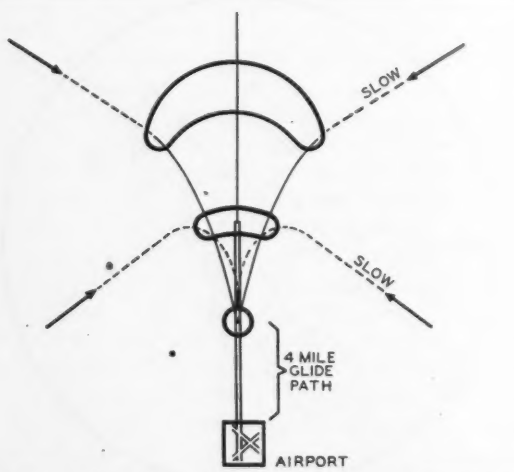

FIG. 10. Paths taken by slow aircraft arriving from any of four directions. Each path is of minimum length; glide path is 4 miles long.

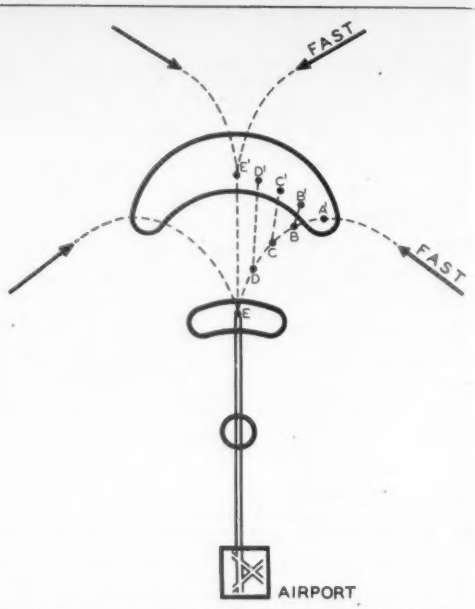

FIG. 11. Paths taken by fast aircraft arriving from any of four directions. Aircraft arriving from southeast enters slow end of block and proceeds, without reducing speed, to point E at start of 8-mile glide path. When plane has reached point B, upper block has moved so that B' coincides with B. Similarly, when plane has reached C, it will still be in the block because C' will have reached C, etc.

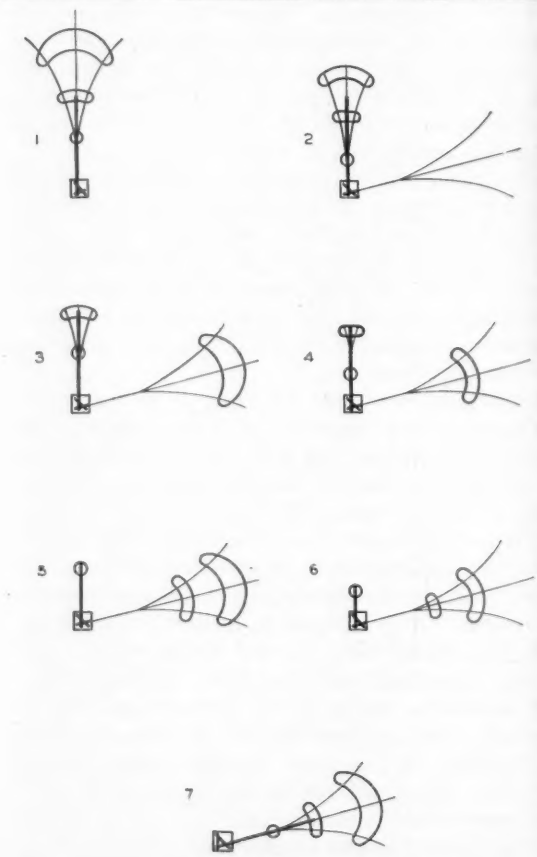

FIG. 12. Successive scenes, 1 min. apart, showing shift to new runway. Aircraft already started for old runway complete their landings. Entire shift requires 6 min.

rapidly than do the ends, thus accounting for the peculiar shapes.

Fig. 10 illustrates the paths taken by slow aircraft arriving from any of four directions. Note that the glide path is only about 4 miles long, which is appropriate for small aircraft. Each flight path is of minimum length. The interval between successive blocks is 2 min. Delays take place only when an aircraft approaching a block finds that that block is filled and must circle to wait for a free one.

Fig. 11 illustrates the paths taken by fast aircraft arriving from any of four directions. In this case an 8-mile glide path is used. Note that fast aircraft approaching from downwind enter the slow end of the block and then make a turn into the glide path, maintaining speed during the turn yet remaining within the block. This is made possible by the changing positions of the blocks as they approach the airport. In a typical case and for no wind, the blocks would be "animated" such that their outer portions move at 110 m.p.h., continuing at this rate down the final approach. The center of the upper block would move at, say, 200 m.p.h., gradually decreasing to 110 m.p.h. at the start of the 8-mile final approach. Slow planes that glide at only 90 m.p.h. would not cause trouble, because during their 4 miles on the final approach such planes fall back only 29 sec. as compared to 110 m.p.h. planes. With 2-min. intervals between successive blocks, a landing that is 29 sec. late would be acceptable.

When a wind change necessitates a shift in runways, a transition film is used. Fig. 12 depicts a runway shift, the successive scenes being spaced at 1-min. intervals. Aircraft already on their final approach for the original runway continue their landing without change. Other aircraft note that a runway shift is to be made as indicated by the appearance in the picture (scene 2) of the path lines for the new runway. The first block for the new runway appears in the third minute. The entire shift is accomplished in 6 min. and no landing intervals are lost. All pilots know the situation at all times, and those who are landing on the old runway know that a slight cross-wind is to be expected. No voice communication is necessary, the picture being more effective, more natural, and succinct.

If mountains or other obstacles necessitate the use of special approaches, the picture can easily allow for this, as shown in Fig. 13. The pilot is readily shown where to go without any voice communications and without reference to aural beams, omni-ranges, ADF's, maps, or other devices.

When the necessary animated films are once prepared for a given airport, they can be used year after year without changes. No computer is needed. How much film is required in a typical case? If it is assumed that the airport has three runways permitting landings from six directions; that the speed of the moving blocks should be varied for winds of 0, 10, 20, 30, 40, and 50 m.p.h.; that the animated blocks should move at least once every 5 sec.; and that traffic must

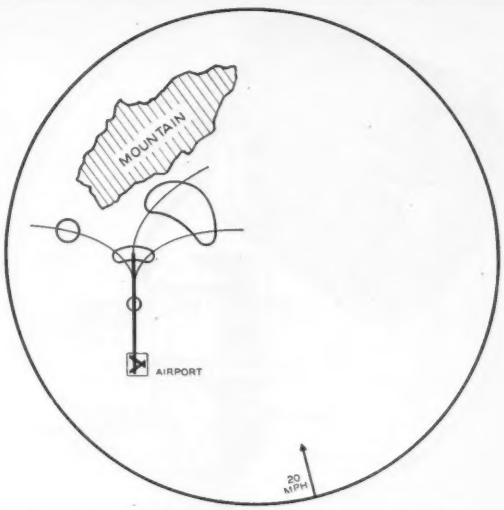

FIG. 13. Type of picture transmitted in area containing a permanent obstacle.

be shiftable from any runway to any other runway under any wind conditions (except for certain improbable cases such as that a given runway with a 50 m.p.h. wind from the north would suddenly be discontinued for use of the same runway with a 50 m.p.h. wind from the south), we find that the loop of film for any one complete cycle of operation must run 6 min., which corresponds to 4 ft. of 16-mm. film, and that a total of 966 films* would be required to handle all steady-state conditions and all transitions. Thus, a total of 3,864 ft. of film would suffice. For the relatively simple type of animation required, this amount of film would not be excessively costly.

If each film is supported in a linear position rather than in a circular closed loop and if the films are placed around a cylindrical rack, they are accommodated on a cylinder 4 ft. long and 5 ft. in diameter. One form of film-scanning machine is depicted in Fig. 14. A selective mechanism operated by push buttons available to the ground controller causes the film drum to rotate until the desired film is before the flying spot scanner. This scanner, which is a simplified form of television camera, moves along the selected film in discreet steps of one frame each. During the interval when the scanner is moving from frame to frame and is not scanning, the picture of the previous frame is automatically retained in a storage tube, which is a normal component of the Teleran system. Although the input to the storage tube is intermittent, its output is a television-like signal that produces a flickerless picture.

The selective mechanism for drum rotation is not shown in the sketch. In the simplest method, the drum is rotated by hand to the desired position, and the correct film is ejected outward an inch or so to make it available for scanning. The time required to rotate

* Following the preparation of this paper, a method became available which greatly reduces the number of films required.

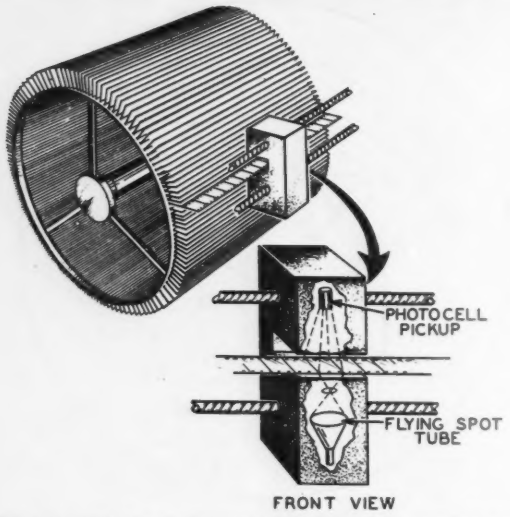

FIG. 14. Film-scanning machine for producing moving block pictures. The desired animated film is scanned by a flying spot scanner. Films are provided for different wind velocities and different runways and for transitions from one wind situation to another.

the drum would cause only one 5-sec. frame to be omitted from the transmission and this would not be important.

In a more elegant method, external buttons are pressed to cause the drum to rotate to the selected position. Standard and well-proved methods are available for accomplishing this. Other common techniques in automatic control can be employed to cause shifts from transition film to steady-state film and repetition of steady-state film to be automatic.

A time interlock controls the transfer from one film to another, so that transition takes place only at the exact termination of each landing interval. In the present example, where landing intervals are assumed to be spaced 2 min., the next film selected by the controller will always start being automatically scanned within 2 min. after he presses the required button, the average delay being 1 min.

Suppose that runway 9 is in use with an east wind of 20 m.p.h. and that the wind shifts to the south at 10 m.p.h. The controller, knowing that runway 18 must be used, presses the button for, "Transition R9 20 m.p.h. to R18 10 m.p.h." Within not more than 2 min. the transition film for this condition starts being transmitted, and 6 min. thereafter the new runway is in use and all aircraft previously headed for runway 9 are landed. Upon the completion of the 6-min. transition period the controller presses the button for "steady state: R18 10 m.p.h." (or this takes place automatically), whereupon *the film for that condition is transmitted repeatedly*, possibly for many hours, until another change is required.

If desired, the entire operation could be made automatic through the use of data from standard meteorological instruments for wind direction and velocity. By routing these data through an integrater, shifts from film to film could be automatic, with the integrater initiating a shift to a new runway only when a change in wind direction exceeds a certain magnitude and lasts, say, more than 10 min. Similarly, changes in the speed of the blocks for changes in wind velocity (and not direction) could be made when and only when the integrated velocity changes by an appreciable amount—i.e., 10 m.p.h. for a period of over 10 min.

With this fully automatic but rather simple arrangement no ground control personnel would be required, yet each pilot arriving in the control zone would be enabled to enter a block of air space and reserve it. The reservation would move at a speed appropriate for his aircraft, would take into account wind conditions, and would conduct him to the proper runway. In practice, a ground controller would be desirable so that, by means of radiophone *or visual directives written in the television-like picture*, emergency instructions could be issued and other special situations could be handled.

For each of the traffic control methods so far discussed, it is realized that the block shapes used for illustration are not necessarily optimum. But the flexibility and ease of interpretation of pictorial display is apparent. The Teleran link between ground and aircraft is unconcerned about the kind of pictorial information carried by it. Thus, without modifying or obsoleting the ground and air-borne equipment constituting the picture link, traffic control procedures can be changed from year to year to better adapt them to the ever changing traffic requirements. Pictorial situation display, in contrast to selective individual communication methods, is a unique form of group communication. It transmits to many persons comprehensive information in a form satisfying the requirements of each individual recipient.

Having discussed methods for controlling traffic in the zone of initial approach, let us now consider the remaining two phases of traffic control—namely, the final approach or instrument landing and the control when on the surface of the ground.

THE INSTRUMENT LANDING PICTURE

Regardless of whether the pilot is flying a military, private, or commercial plane, scheduled or nonscheduled, under fixed block or moving block traffic control, when he reaches the start of the final approach (glide path) he enters the second phase of traffic control—that is, he utilizes his instrument landing system. During his flight down the glide path, the single path into which all others converge, he is still under traffic control. In fact it is in this part of his flight that he intentionally is spaced closer to other aircraft than at any other time he is air-borne. This point is important.

The SC-31 recommendations provide ILS and GCA and pictorial situation display for final descent. Since the pictorial display gives the pilot all of the information that he gets from the standard ILS system, as well

as GCA information to allow him to *talk himself down rather than be talked down by a ground controller*, it seems probable that eventually pilots will use the picture as the primary means of accomplishing the final approach, with any other means reserved for use as a check and in emergencies. An important point is that it will be the pictorial situation display that will show the pilot the *location of other aircraft ahead of and behind him on the final approach.*

One type of landing display has been previously described.[4] Fig. 15 is a typical picture seen by a pilot when he first switches on his landing display at the start of the final approach. As before, he sees himself as a spot moving on a map. He immediately sees whether he is right or left with respect to the approach path, as well as his distance from the airport. He sees an actual map of the airport and has visual information regarding wind. A horizontal line produced automatically within the Teleran equipment represents the elevation of the glide path with respect to his aircraft. In the case illustrated, the pilot of the aircraft 7 miles from the airport finds himself slightly to the right of, and above, the glide path. The aircraft 3 miles from the airport is exactly in position. As an aircraft proceeds toward the airport, so does the horizontal line, with the aircraft's distance above or below the horizontal line indicating distance above or below the glide path. This indication becomes more sensitive as the airport is approached.

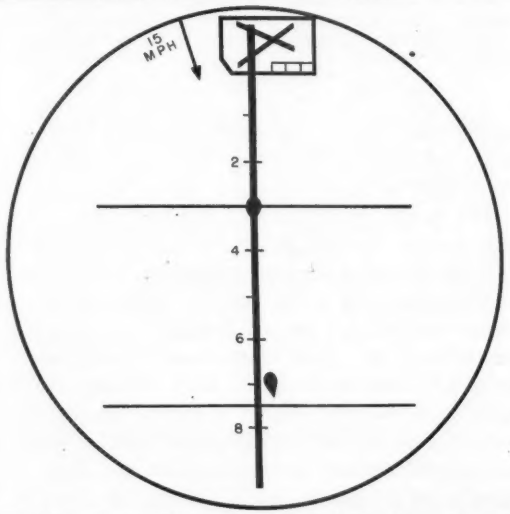

FIG. 15. Typical pictorial display during instrument landing. Pilot at 7 miles from airport is slightly high and to the right. He notes that the approach path is free except for plane at 3 miles. That plane is exactly on proper path.

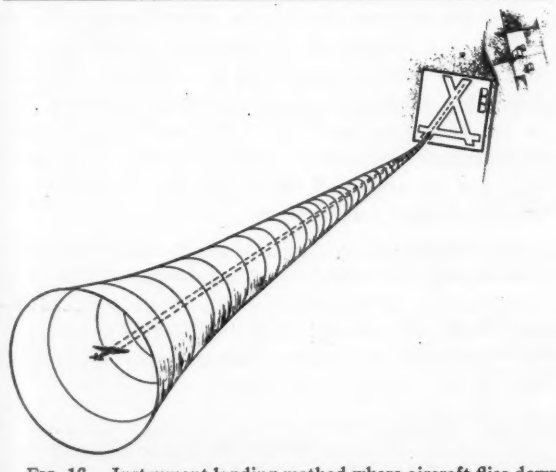

FIG. 16. Instrument landing method where aircraft flies down center of imaginary cone whose apex is at point of contact. Cone can be bent at lower end to produce flare-out.

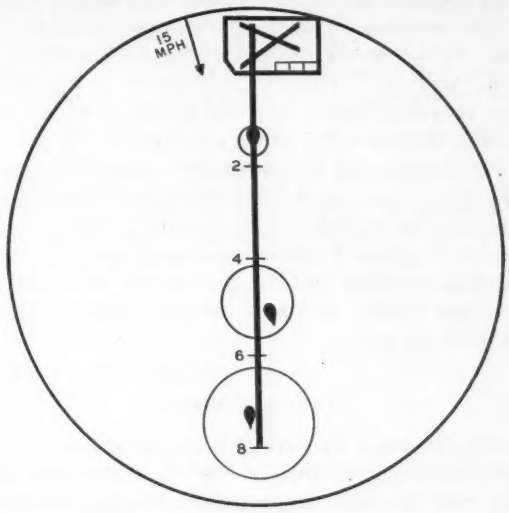

FIG. 17. Picture actually received when making instrument landing by method of Fig. 16. Accuracy of flight is greatest where cone cross section (circle) is small. This is near the airport where greatest precision is required. Pilot 5 miles from airport is to the right and slightly low.

An alternative landing method is shown in Fig. 16. The pilot imagines he is proceeding toward the airport inside of a cone whose apex terminates on the airport. The apex end of this cone can be "bent" to provide flare-out. Referring to the actual received picture as shown in Fig. 17, as the pilot enters the far (large) end of the cone, he sees his location within a large circle representing the cross section of the cone. Distance from the airport is continuously and obviously shown. As the airport is approached, decreased circle size corresponds to diminution of cone section, enabling the pilot to center his aircraft more accurately within the circle (i.e., place it on the glide path). In the illustration, the aircraft 5 miles from the airport is to the right and slightly low. All aircraft on the path are shown simultaneously. To resolve any ambiguity as to which indication refers to his plane, the pilot need merely press a button to interrupt the operation of his transponder, whereupon his spot fades momentarily from the picture.

The data for producing the landing display of either Fig. 15 or Fig. 17 is obtained from standard GCA equipment. For landing unequipped aircraft, the GCA equipment would continue to be used as it is today. Over 100 pilots have made instrument landings

in a Teleran Link trainer equipped with the Fig. 15 type of presentation. Comments were very favorable. Actual flight tests are presently being conducted by the U.S. Air Force. The pictorial method of Fig. 17 has not been flight-tested, and thus its merits as compared to the method of Fig. 15 are not known.

With improved flight control instruments such as the Sperry "zero-reader" (which incorporates automatic anticipation of flight characteristics), combined with pictorial display to show the overall progress of the landing operation and the presence of other aircraft, landings under near-zero ceilings should become routine and safe.

Taxiing Control

Finally, when the aircraft is on the ground, it may still need traffic control. A few years from now landings will be made under truly zero-zero conditions. The pilot will find himself on the ground but unable to see through the half mile or so of fog separating him from the ramp or hangar. His aircraft *will constitute a serious hazard on the airport surface.* Some means of expediting and controlling its motion will be required.

A picture in the cockpit showing the airport situation, along with visual instructions about where to taxi, would give the pilot the necessary information. SC-31 considered that pictorial situation display is *the only known means* for adequately controlling traffic on the airport surface under true zero-zero conditions.

A fully practical method for detecting the location of all aircraft on the surface of an airport is not yet available, but several are being investigated. It is safe to assume that a satisfactory method will be available by the time pictorial display equipment is widely installed. Fig. 18 shows the kind of display that could be used. The particular map or slide placed before the television camera is for a southwest wind condition when runway No. 21 is used. The plane near the start of the runway is "held" by a bar. It can proceed to taxi for take-off when the bar is removed from the picture by the airport controller. The camera also picks up a handwritten instruction for aircraft No. 766. This instruction is erased as soon as No. 766 has returned to its hangar. Again the *flexibility and convenience* of the pictorial method is apparent.

Conclusions

It is shown that air traffic control can be accomplished in a new manner wherein all necessary information is presented to ground and air-borne personnel by television-like pictorial situation displays. Pilots need not concern themselves with aural traffic control instructions, approach zone maps, final approach maps, ADF's, localizer beams, glide path beams, complicated holding courses, and critical altitude stacking instructions, but instead they can receive from a teleran picture all of the information given by the multitudinous means used today plus other information totally unavailable today but necessary for safe traffic control in the future.

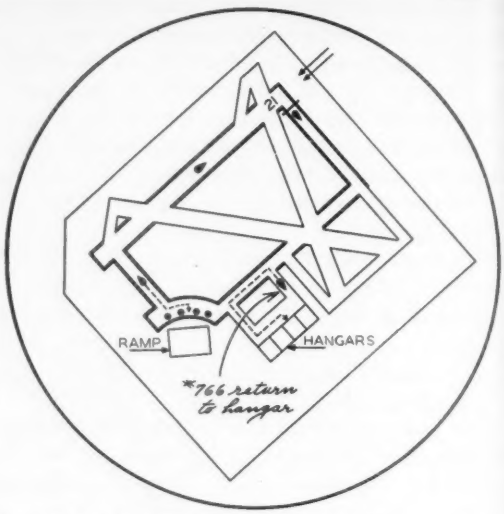

Fig. 18. Typical display for use when taxiing on the airport surface. Note that instructions for one plane have been inserted by hand. They will be erased when the plane has carried out the instructions.

The flexibility of pictorial display makes it adaptable for use by rigidly scheduled, flexibly scheduled, and nonscheduled aircraft, employing fixed or moving block methods of traffic control. Changes in control procedures will not require changes in the ground-to-air picture link. New traffic control paths are made by merely drawing lines on a map, altitude stacking is replaced by superior control of lateral spacing, and information to prevent collision with both equipped and unequipped aircraft is conveniently available. Consistency of interpretation is provided so that at all times—when under initial control, during final approach, when taxiing on the ground and during take-off—the pilot always sees his aircraft as a spot moving on a map.

Specific pictorial displays for several types of traffic control are illustrated. A method permitting flexibility in scheduled operations is available. For nonscheduled aircraft, a unique "moving stairway" type of variable speed moving block control is proposed. It requires no ground computer, because instructions originate on animated films that are computed once and for all when manufactured.

The psychological appropriateness of pictorial situation display for traffic control is apparent. The flying of aircraft by television-like diagrammatic pictures may well constitute not only a desirable solution to a complex psychophysics problem but an important forward step in the history of aviation.

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Engineering Problems of a Small Pusher Design

(*Continued from page 21*)

Accessibility to the top of the engine is through an upper cowl built all in one piece and hinged alligator style off the cabin roof near the main bulkhead. Lower engine compartment cowls are individually removable with Dzus fasteners.

The exhaust system is muffed fo carburet or and cabin heat. The exhaust gasses pass through the airplane bottom and are directed downward to prevent them from impinging on the propeller and causing noise and vibration. The carburetor inlet has what at first appears to be a rather odd location since it is on the airplane centerline facing directly aft. Pressure checks reassure that the location is favorable, and this location makes for the simplest possible connection to the carburetor.

Specifications—Anderson, Greenwood Model 14 (Fig. 6):

Wing span	34 ft.
Wing area	120 sq.ft.
Landing gear tread	84 in.
Gross weight	1400 lbs.
Useful load	550 lbs.
Baggage (two occupants, 20 gal. fuel)	75 lbs.
Maximum baggage or cargo	250 lbs.
Seat width	44 in.
Range on 23 gal.	4 hours
Top speed	over 120 m.p.h.
Cruising speed	over 110 m.p.h.
Rate of climb	over 700 ft. per min.
Power (Continental C-90 engine)	90 hp.

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Testing of Jet Engines

Under Simulated Air-Speed and Altitude Conditions

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ABSTRACT

The testing of jet engines and associated air ducting systems in either open or closed tunnels presents serious problems. In closed tunnels the problems of dissipation of the heat generated within the engines and the interference due to tunnel walls are troublesome. In open tunnels the power required to obtain a stream of sufficiently large cross section is relatively large. In both cases the problem of evaluating the internal performance of the engine separately from the effects of the external airflow poses a formidable problem, which, in the case of pulsating flow engines, cannot be satisfactorily solved with any degree of accuracy.

The use of pressurized tanks, to which the engine may be directly attached, avoids many of the problems indicated above. The effect of forward air speed and altitude can be simulated in this fashion. The installation costs and power requirements for such an installation are much lower than for a tunnel installation. The evaluation of the internal performance of the engine from the test data is simplified.

The scheme of using pressurized tanks, is, of course, open to the objection that the effects of external flow on the internal performance of the engine, if such effects exist, are not accounted for. Furthermore, in the case of pulsating engines, care must be taken to reduce to a negligible state any pressure wave reflections in the tank which are not characteristic of free-flight operation. However, the system indicated permits the obtaining of useful performance data with a relatively small expenditure of time and effort and at a low cost.

NOMENCLATURE

P	=	pressure, lbs. per sq.ft.
V	=	velocity, ft. per sec.
T	=	temperature, °R.
ρ	=	density, lbs. per cu.ft.
a, A	=	surface area and cross-sectional area, sq.ft.
w	=	rate of flow, lbs. per sec.
F	=	thrust, lbs.
M	=	Mach Number

INTRODUCTION

THE PROBLEM OF evaluating the internal performance of a jet engine under conditions encountered over a wide range of forward air speeds and altitudes may be approached in several ways.

(a) A closed tunnel installation, provided with facilities for varying the free-stream static pressure, may be employed. In this instance, provisions must be made for dissipating the heat of the exhaust gases and continually providing fresh air for the intake.

(b) An open tunnel may be used in which the engine is mounted directly aft of the exhaust nozzle of the tunnel. In this instance altitude conditions cannot be simulated, and a stream cross section several times the area of the engine cross section must be employed in order to represent satisfactorily forward air-speed conditions.

(c) Flight testing may be employed to evaluate the performance of the jet engine. In this instance the speed and altitude range that may be investigated is limited to the range of the aircraft carrying the equipment. In view of the fact that the speed ranges of interest for jet engines are above those attainable by present suitable flight-testing aircraft, this constitutes a severe limitation.

(d) A fourth method of approach is to use a continually pressurized tank, to which the jet engine is directly attached, to simulate the ram pressure to which the engine is subjected under free-flight conditions. Altitude simulation may be obtained by attaching a tank, which may be continually evacuated to a lower-than-atmospheric pressure, to the exhaust of the engine. Flexible couplings or impact plates in the jet exhaust stream may be used to make thrust measurements.

One of the principal advantages of the last-mentioned method of testing is the fact that the internal performance of the engine is directly evaluated. In the other approaches, the measured thrust includes the effect of external drag, and measurements, such as external air momentum surveys, must be made in order to obtain a "figure of merit" for the internal performance. In the case of steady flow engines, this can be done with reasonable accuracy. In the case of pulsating flow engines, the results so obtained would be of dubious accuracy, since the "average" pressures obtained with static and pitot probes would not give accurate results in calculating momentum conditions in the external stream.

The pressurized tank method of testing is discussed in detail in the following analysis. Consideration is also given to the basic question of the "figure of merit"

Presented at the Annual Summer Meeting, I.A.S., Los Angeles, July 14–16, 1948.

* Department of Engineering and Director of Research, respectively.

generally used in evaluating the thrust performance of an engine and in comparing performances of different jet engines.

Figure of Merit for Jet Engine

In order to describe adequately the thrust available for accelerating a bare engine, such as is shown in Fig. 1, upstream, attention must be concentrated not only on the fluid that passes through the engine but also on the air that passes outside the engine. It may be readily shown that the accelerating thrust on an engine such as is shown in Fig. 1 (in a nonviscous compressible fluid and where $P_2 = P_0$) is given by*

$$F' = \frac{w}{g}(V_2 - V_0) - \int_{a_s + a} (P - P_0) \cos \alpha \, da \quad (1)$$

where

F' = accelerating thrust
w = rate of flow of fluid through engine
P_0, V_0 = free-stream pressure and velocity
V_2 = engine exhaust velocity
g = acceleration of gravity
P = local static pressure
a_s = boundary area of stream tube leading to engine inlet from free stream (as shown by dotted lines in Fig. 1)
a = external surface area of engine
α = angle between surface normal and forward axial direction

The first term on the right-hand side of Eq. (1) has been customarily used as a figure of merit for a jet engine. It permits the engine designer to concentrate his attention on the behavior of the air that flows through the engine, leaving for the aerodynamicist the problem of investigating external conditions in the flow fluid. (The effect of adding fuel may be readily accounted for by simply adding to the first term on the right-hand side the rate of change of momentum of added fuel.) The quantity $(w/g)(V_2 - V_0)$ will be called the "net internal thrust" of the engine.†

The physical significance of the term $(w/g)(V_2 - V_0)$ is not readily apparent in the general case (for detailed analysis see Appendix). It is shown in the Appendix (and in reference 1) that the net internal thrust is equal to the measured thrust if the intake to the engine is at free-stream conditions and if the outside surface of the engine is kept at atmospheric pressure. This leads to the possibility of testing jet engines in a free stream by diverting the flow of air away from the outside of the engine by means of a baffle plate at the inlet of (but not connected physically to) the engine. This method may also be used, if the inlet is not at free-stream conditions, by measuring inlet pressure and applying the correction term derived in Appendix.

* This neglects the effect of addition of fuel within the engine.

† This quantity has been alternatively called "net thrust" and "gross thrust." The author's choice of nomenclature is only in the interest of avoiding confusion. There is a need for standardization of nomenclature in this respect.

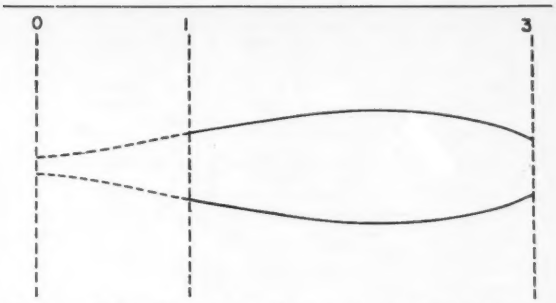

Fig. 1. Schematic diagram of jet engine in free air stream.

The second term on the right-hand side of Eq. (1), which may be also expressed in terms of an integral of the quantity $(P + \rho V^2/g)$ over a surface surrounding the engine,‡ may be termed the "drag" of the engine. The justification for separating these portions of the accelerating thrust on the engine lies in the fact that the type of air-frame structure to which, or within which, the engine is mounted will alter completely the "drag" characteristics.

The engine designer cannot anticipate the variety of structures with which an engine may be associated, and, hence, it becomes advisable to consider only the net internal thrust, as here defined. Thus, the net internal thrust of an engine is not a complete measure of the merit of a particular engine, since the nature of the internal flow affects the external drag, but serves rather as a starting figure from which the performance of the entire aircraft may be evaluated.

As a pointed (although possibly not practical) illustration of the fact that the quantity $(w/g)(V_2 - V_0)$ is not a complete (or in this case, even indicative) measure of the performance of a jet engine, consider the circular cylindrical tube, shown in Fig. 2, placed in a free air stream and having a heat source in its interior. Neglecting frictional effects, this unit is essentially a zero thrust device, since all pressure forces act normal to the surface. However, a solution of the equations (shown below the figure) governing the flow of the fluid (assumed to be air) which passes through the pipe leads to a positive value of 600 ft. per sec. for the quantity $(V_2 - V_0)$ under the free-stream conditions assumed. Or, for a rate of flow of 1 lb. per sec., there is obtained a "net internal thrust" of about 19 lbs. This simply means that the external flow must be investigated before an adequate measure of performance may be arrived at.

Testing by Using Pressurized Tanks

The testing of jet engines by attaching them directly to a pressurized tank to simulate forward air speed and by evacuating the region near the exhaust to simulate altitude permits the experimental determination of the net internal thrust of the engine with relative ease. It avoids the necessity of determining either experimentally or analytically the external "drag" of the

‡ See, for example, reference 2.

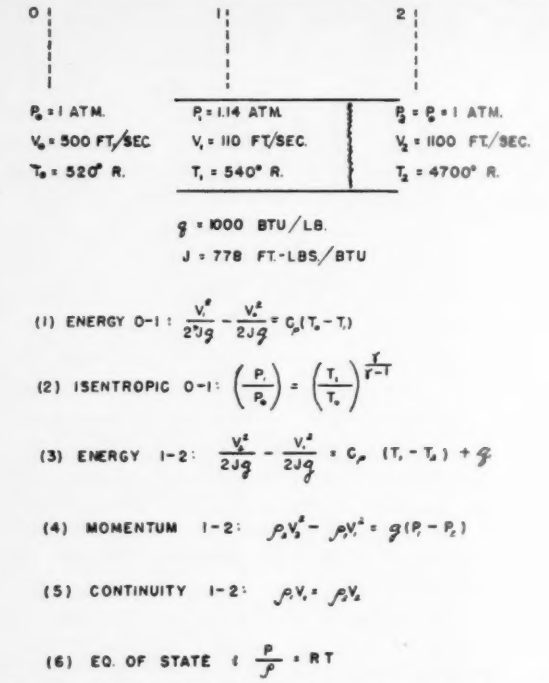
0
1
2
P_0 = 1 ATM.
V_0 = 500 FT/SEC.
T_0 = 520° R.
P_1 = 1.14 ATM.
V_1 = 110 FT/SEC.
T_1 = 540° R.
$P_2 = P_0$ = 1 ATM.
V_2 = 1100 FT/SEC.
T_2 = 4700° R.
g = 1000 BTU/LB.
J = 778 FT.-LBS./BTU
(1) ENERGY 0-1: $\frac{V_1^2}{2Jg} - \frac{V_0^2}{2Jg} = C_p(T_0 - T_1)$
(2) ISENTROPIC 0-1: $\left(\frac{P_1}{P_0}\right) = \left(\frac{T_1}{T_0}\right)^{\frac{\gamma}{\gamma-1}}$
(3) ENERGY 1-2: $\frac{V_2^2}{2Jg} - \frac{V_1^2}{2Jg} = C_p(T_1 - T_2) + g$
(4) MOMENTUM 1-2: $\rho_2 V_2^2 - \rho_1 V_1^2 = g(P_1 - P_2)$
(5) CONTINUITY 1-2: $\rho_1 V_1 = \rho_2 V_2$
(6) EQ. OF STATE: $\frac{P}{\rho} = RT$

FIG. 2. Cylindrical tube in free air stream with heat addition within tube.

unit. The other methods of testing require this determination in order that the figure so obtained may be added to the thrust read on the scales in order to obtain the "net internal thrust" of the engine. The scale reading in the latter case is obviously not significant, since the unit presumably will eventually be mounted in an air frame and external flow conditions will be greatly altered.

A schematic test facility of this nature is shown in Fig. 3, with banks of compressors pressurizing the ram chamber and evacuating the altitude chamber. Cooling of the exhaust gases may be obtained by spraying water into the hot gases in the altitude chamber. Alternatively, steam jets may be used in connection with the altitude chamber in order to effect a low pressure.

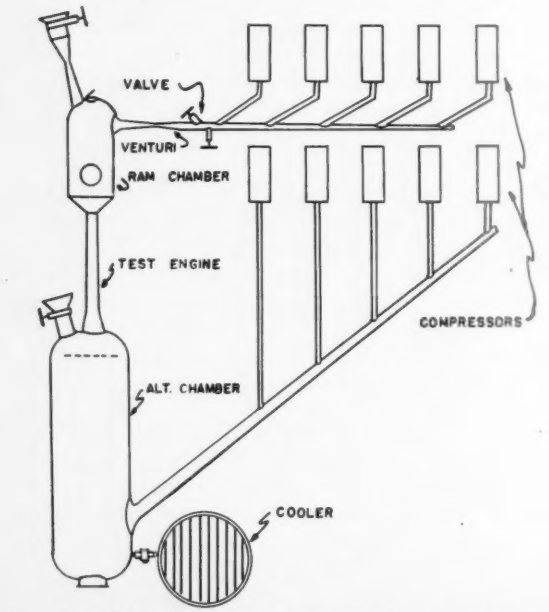

FIG. 3. Schematic diagram of test facilities for simulating forward air speed and altitude conditions.

SEA-LEVEL TESTING

Testing at sea level, or local altitude conditions, requires the use of only the ram chamber. The chamber, with the attached jet engine, may be mounted on a thrust measuring device and a direct reading made of the thrust. A flexible coupling at the inlet to the tank is required. The indicated thrust must be corrected, since it is, in fact, the quantity $(w/g)V_2$. To obtain the net internal thrust of the engine, the free-stream air momentum, $(w/g)V_0$, must be subtracted from the indicated reading. The rate of flow is easily measured by means of venturis in the line, and the free-stream velocity V_0 corresponding to the known ram pressure in the tank may be readily calculated using either assumed or experimentally determined diffuser efficiencies.

ALTITUDE TESTING

Testing under simulated altitude conditions involves experimental difficulties over and above the use of the altitude chamber. A jet engine and ram chamber placed *physically* at the desired altitude would yield a scale reading equivalent to that discussed in the previous section, which could be readily corrected for free-stream air momentum. However, the scale reading will be different when the same jet engine and ram chamber are used in conjunction with an altitude chamber at, say, sea level, even though the altitude chamber is mounted to the exhaust of the jet engine with a frictionless slip fit. The necessary additional correction is indicated schematically in Fig. 4. The reading on the scales mounted on the ram chamber-jet engine combination will change because of the existence of sea-level pressure, instead of altitude pressure on the *outside* of the tank. The difference will be equal to

$$(P_0 - P_a)A_e \qquad (2)$$

where

P_0 = ambient pressure
P_a = pressure at simulated altitude
A_e = outside cross-sectional area of jet engine at the section where the altitude chamber slip joint is located

The correction given by Eq. (2) may, unfortunately, be several times larger than the net internal thrust of the engine. For example, if the pressure altitude under consideration is one-half atmosphere and the area A_e =

1 sq.ft., the correction (2) would be of the order of 1,000 lbs., whereas the net internal thrust of the jet engine might be of the order of 300 lbs. Obtaining the net internal thrust would thus require subtracting two relatively large numbers to obtain a relatively small one, with the consequent errors.

This difficulty may be avoided by using an impact plate to measure the rate of momentum production in the exhaust stream of the engine. The only correction required to this figure would be, as before, the momentum of the free-stream air. Such an impact plate could be mounted on a thrust-measuring device within the altitude chamber, as shown by the dotted lines in Fig. 3. Impact plates of this type have been used in sea-level testing and can, in fact, be reasonably accurately calibrated.

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Appendix

Thrust on a Jet Engine

A jet engine in a free air stream is shown schematically in Fig. 1. The physical thrust (positive to the left) experienced by the engine as a result of the pressure forces* acting on it may be expressed as follows:

$$F_T = \int_a P \cos \alpha \, da + \int_{a'} P' \cos \alpha' \, da' \quad \text{(A1)}$$

where

F_T = total axial force on engine
P = static pressure on inside wall of engine
P' = static pressure on outside wall of engine
α, α' = angle the normal to the inside and outside surfaces, respectively, make with the rearward axial direction
a, a' = inside and outside surface areas, respectively

The force experienced by the air inside the engine (positive to the right) is

$$F_g = \int_a P \cos \alpha \, da + P_1A_1 - P_2A_2 = \frac{w}{g}(V_2 - V_1) \quad \text{(A2)}$$

where

F_g = total axial force on gas
P_1, P_2 = static pressure at inlet and exhaust, respectively
A_1, A_2 = cross-sectional area of inlet and exhaust, respectively
w = rate of flow of gas through engine

* Frictional forces due to air viscosity are neglected here.

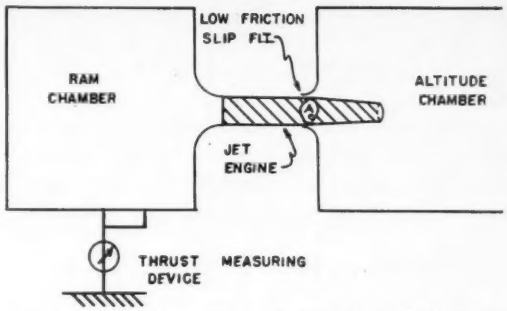

Fig. 4. Schematic diagram of ram and altitude chamber.

V_1, V_2 = entrance and exhaust velocity, respectively
g = acceleration of gravity

The right-hand member of Eq. (A2) is the rate of change of momentum of the gas passing through the engine, which, by Newton's Second Law, is equal to the force acting on the fluid. Eq. (A2) neglects the effect of additives such as fuel to the air stream. The addition of fuel will not affect the basic considerations and serves only as a minor correction to the member on the right-hand side of Eq. (A2).

Now if $P' = P_0$ (i.e., the external surface is kept at atmospheric pressure by artificial means), then

$$F_T = \int_a P \cos \alpha \, da + P_0 (A_1 - A_2) \quad \text{(A3)}$$

and for $P_2 = P_1 = P_0$ (hence, $V_1 = V_0$), we have

$$F_g = (w/g)(V_2 - V_0) = F_T$$

or, the net internal thrust† is equal to the physical thrust experienced by the engine when the inlet velocity is equal to free-stream velocity and the external surface is subjected to atmospheric pressure. This result has been previously shown in reference 1.

When $P_1 \neq P_0$ (i.e., when external diffusion is permitted to occur), then, for $P_2 = P_0$,

$$\text{Net internal thrust} = \frac{w}{g}(V_2 - V_0) = \frac{w}{g}(V_2 - V_1) - \frac{w}{g}(V_0 - V_1) = \int_a P \cos \alpha \, da + P_1A_1 - P_0A_2 - \frac{w}{g}(V_0 - V_1) \quad \text{(A4)}$$

and, comparing Eqs. (A3) and (A4),

$$w/g \, (V_2 - V_0) = F_T$$

only if

$$P_1A_1 - (w/g)(V_0 - V_1) = P_0A_1$$

or since $w = \rho_1 A_1 V_1$, if

$$A_1(P_1 - P_0) = (\rho_1 A_1 V_1/g)(V_0 - V_1)$$

That the above condition cannot hold may readily be seen by letting $V_1 \rightarrow 0$ (by letting A_2 become small).

† As defined in body of the report.

This would predict that $P_1 \rightarrow P_0$, which is obviously in error.

The net internal thrust of the unit when external diffusion occurs may be obtained from the measured thrust, F_T, when the external surface is kept at atmospheric pressure by applying a correction based on the measured value of P_1. The correction term may be obtained as follows: Eq. (A4) may be rewritten

$$\text{Net internal thrust} = \frac{w}{g}(V_2 - V_0) =$$

$$\int_a P \cos\alpha \, da + P_0A_1 - P_0A_2 + P_1A_1 -$$

$$P_0A_1 - \frac{w}{g}(V_0 - V_1) = F_T +$$

$$P_1A_1\left(1 - \frac{P_0}{P_1}\right) - \frac{wV_0}{g}\left(1 - \frac{V_1}{V_0}\right) \quad \text{(A5)}$$

The ratio V_1/V_0 may be obtained in terms of free-stream conditions and the pressure P_1 by using the energy equation relating conditions at the inlet to conditions in the free stream—namely,

$$V_0^2 - V_1^2 = \frac{2\gamma gRT_0}{\gamma - 1}\left(\frac{T_1}{T_0} - 1\right) \quad \text{(A6)}$$

where

γ = specific heat ratio = C_P/C_V
R = gas constant
T = absolute temperature

Combining Eq. (A6) with the isentropic relationship

$$T_1/T_0 = (P_1/P_0)^{(\gamma-1)/\gamma} \quad \text{(A7)}$$

and the relationship

$$M_0^2 = V_0^2/\gamma gRT_0 \quad \text{(A8)}$$

where M_0 = free-stream Mach Number, we obtain

$$\left(\frac{V_1}{V_0}\right)^2 = 1 - \frac{2}{(\gamma-1)M_0^2}\left[\left(\frac{P_1}{P_0}\right)^{(\gamma-1)/\gamma} - 1\right] \quad \text{(A9)}$$

Further, the quantity wV_0/g in Eq. (A5) may be written

$$wV_0/g = \rho_1A_1V_1V_0/g$$

where ρ_1 = inlet density, which, when combined with Eqs. (A7), (A8), and the equation of state $P_1/\rho_1 = RT_1$, yields

$$\frac{wV_0}{g} = \gamma P_1A_1M_0^2\left(\frac{P_0}{P_1}\right)^{(\gamma-1)/\gamma}\left(\frac{V_1}{V_0}\right) \quad \text{(A10)}$$

and Eq. (A5) becomes

$$\text{Net internal thrust} = F_T + P_1A_1 \times$$

$$\left[1 - \frac{P_0}{P_1} - \gamma M_0^2\left(\frac{P_0}{P_1}\right)^{(\gamma-1)/\gamma}\left(\frac{V_1}{V_0}\right)\left(1 - \frac{V_1}{V_0}\right)\right] \quad \text{(A11)}$$

where V_1/V_0 is given by Eq. (A9).

Hence, the correction term on the right-hand side of Eq. (A11) is a function only of the measured inlet pressure and free-stream conditions and can be applied to the measured thrust F_T to obtain the net internal thrust of the engine.

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I.A.S. Briefs

Summaries of current papers accepted for publication or presentation at I.A.S. Meetings

An Empirical Study of Low Aspect Ratio Lifting Surfaces with Particular Regard to Planing Craft

By

F. W. S. Locke, Jr.

Navy Department

This report presents the results of a brief empirical study of the lift characteristics in incompressible flow of low aspect ratio lifting surfaces. It is indicated that for aspect ratios less than about 2.0, the lift coefficient can be estimated with reasonable accuracy by

$$C_L = \eta K \alpha^n$$

K and n depend only on the aspect ratio, and η is primarily a function of the operating conditions. Having assumed η to be unity for rectangular plan-form airfoils, it is then found that η is 2/3 for hulls making leeway and 1/2 for flat bottom planing surfaces.

Generalized Charts for Determination of Pressure Drop of a High-Speed Compressible Fluid in Heat-Exchanger Passages

By

Michael F. Valerino

Lewis Flight Propulsion Laboratory, National Advisory Committee for Aeronautics

The usual approximation made in calculating the pressure changes of a compressible fluid flowing through heat-exchanger passages introduce appreciable errors in the range of high flow Mach Numbers and high rates of heating. Existing methods for obtaining accurate results over the entire Mach Number and rate of heating range require numerical integration for each set of conditions and are thus too tedious for general application.

In the present paper an analysis is made of the compressible-flow variations occurring in heat-exchanger passages. The results of the analysis describe the flow and heating characteristics for which specific flow passages can be treated as segments of generalized flow systems. The graphical representation of the flow variations in the generalized flow systems can then be utilized as working charts to determine directly the pressure changes occurring in any given flow passage for any given flow and heating conditions. Working charts that have been constructed on the basis of these results to handle the case of air heated at constant wall temperature under turbulent fluid-flow conditions are discussed. A method is given of incorporating the effect on the heat-exchanger flow process of high temperature differential between passage-wall and fluid as based on recent N.A.C.A. experimental data. Good agreement is obtained between the experimental and the chart pressure-drop values for passage-wall average temperatures as high as 1,700°R. (experimental limit) and for flow Mach Numbers ranging from 0.32 to 1.00 (choke) at the passage exit.

Please do not order Preprints of these papers at this time.

See page 42 for Preprints that are immediately available.

The Oscillating Wedge in a Supersonic Stream

By

G. F. Carrier

Brown University

When an obstacle in a fluid stream is allowed to execute oscillations, the pressure distribution on the obstacle will be modified. Such a modification frequently implies a dynamic stress resultant which leads to the flutter phenomenon. Theoretical investigations of this situation for those cases where the stream is supersonic and the obstacle is slender have been pursued by several authors. A rather complete bibliography and a detailed summary of these investigations can be found in reference 1. It is to be noted that each of these investigations relies on a linearized theory (i.e., a perturbation of a given steady flow) and neglects the presence of the shock wave. If one adopts the point of view that the oscillating obstacle produces acoustic waves that must reflect from the shock, it is evident that the dynamic pressure distribution may be considerably modified by these wave reflections. It therefore seems of importance to determine the modifications that arise in the theory of an oscillating airfoil in a supersonic stream when one takes the presence of the shock into account.

The present paper is a presentation of such a modified theory for an oscillating wedge. Specifically, we shall consider a wedge of finite chord and infinite span which executes small oscillations about its leading edge. The perturbation wave functions are determined in a conventional product-series expansion, and recurrence formulas for the associated coefficients are readily obtained. The results are compared to those for the no-shock (i.e., indefinitely thin airfoil) situation.

Problems and Progress in Low Pressures Research

By

E. D. Kane and R. G. Folsom

University of California at Berkeley

The nature of the theoretical and experimental problems associated with the field of rarefied gas dynamics is discussed. The types of laboratory equipment judged to be most suitable for studying these problems are low-pressure supersonic wind tunnels, molecular beams, and rotating cylinders. Experimental results with a model wind tunnel and typical supersonic nozzles illustrate the existence of the expected large viscous effects and possible slip at the boundary. The techniques used and under development for pressure measurement and flow visualization are described.

Two-Dimensional Airfoils in Hypersonic Flows

By

Richard D. Linnell

Massachusetts Institute of Technology

Equations for the force and moment coefficients of a sharp-edged two-dimensional airfoil are developed on the basis of Tsien's hypersonic similarity law. The coefficients are calculated for a flat plate and for three airfoils with thickness. The optimum airfoil is a wedge whose lower surface is flat, with the maximum thickness at mid-chord. The results are valid when the product of the Mach Number and the thickness ratio is of the order of 1.

Applications of the Theory of Free Molecule Flow to Aeronautics

By

Holt Ashley

Massachusetts Institute of Technology

The breakdown of certain assumptions of conventional aerodynamics in the case of highly rarefied gas is shown to call for the use of the theory of free molecule flow in studying forces on bodies moving above 120–150 km. in the earth's atmosphere. A tentative standard table of atmosphere properties from 120–220 km. is computed. The parameter M^{∞}, ratio of flight speed to most probable speed of air molecules, becomes useful in comparing free molecule flows.

Techniques are developed for finding analytically or numerically the lift and drag coefficients of any object, based on two extreme opposite assumptions concerning the nature of reflection of molecules from surfaces. These methods are employed to find coefficients of a number of simple bodies.

The drag of missiles is demonstrated to be negligibly small above 120 km. except at extremely high speeds. The possibility of aerodynamically sustained flight is discussed.

Notes on Column End Fixity Coefficients

By

G. C. Best

Consolidated Vultee Aircraft Corporation

The theory relating elastic end restraint to end fixity coefficients for beams of constant section is developed in a somewhat different manner than heretofore. A new and simple graphical relation results from which arises an approximate formula of an accuracy adequate for engineering purposes. Also an approximate formula discovered by N. M. Newmark is shown.

The Analytical Design of an Axially Symmetric Laval Nozzle for a Parallel and Uniform Jet

By

Kuno Foelsch

Consulting Physicist and Aerodynamicist

The equations for the nozzle's contours are derived by integration of the characteristic equations of the axially symmetric flow. Since it is not possible to integrate these equations mathematically in an exact form, it was necessary to find a way to approximate the calculations. The approximation offers itself by considering and comparing the conditions of the flow in a cone with those in a nozzle, as a linearization of the characteristic equations.

The first part of the report deals with equations for the transition curve by which the conical source flow is converted into a parallel stream of uniform velocity. The equations are derived by integration along a Mach line of the flow in the region where the conversion takes place. A factor f is introduced expressing a relation between the direction and the velocity of the flow along a certain Mach line. f remains undetermined and is not involved in the final equations.

In the second part of the report the spherical sonic flow section is converted into a plane circular section of the throat. The nozzle's contour adjacent to the throat is formed for the arc of a circle connected with the transition curve by a straight line. The gas dynamic properties of the boundary Mach line are calculated in Table 1, the use of which shortens the calculations considerably.

On the Addition of Heat to a Gas Flowing in a Pipe at Subsonic Speed

By

Joseph V. Foa and George Rudinger

Cornell Aeronautical Laboratory

It is shown that, contrary to widely accepted opinions,

(a) The addition of heat to a subsonic flow in a pipe modifies the flow conditions both downstream and upstream of the region of heat addition.

(*b*) The Mach Number of the heated flow does not necessarily increase, approaching the sonic state, when heat is added; instead, it will increase or decrease, depending on the boundary conditions.

(*c*) The static temperature of the gas does not decrease when heat is added within the range of initial Mach Numbers from $1/\sqrt{\gamma}$ to 1.0; instead, it increases continuously.

(d) The attainment of sonic velocity in the heated region does not limit the amount of heat that can be added.

(e) The mass flow may decrease as a result of the addition of heat, but this decrease is in no way related to the attainment of sonic velocity in the heated region.

A quantitative treatment of the problem is presented for the cases of greatest practical interest, and numerical examples are given to illustrate the procedures and conclusions.

Experiments on a Laminar Suction Airfoil of 17 Per Cent Thickness

By

W. Pfenninger

Institute for Aerodynamics, Swiss Federal Institute of Technology

Boundary-layer suction experiments have been carried out on a 17 per cent thick laminar airfoil in the 7 by 10 ft. wind tunnel of the Institute for Aerodynamics at the Federal Institute of Technology, Zürich. With small suction quantities ($c_{Q_t} = 0.0014$ to 0.0018) the boundary layer could be kept completely laminar on both sides of the airfoil within a considerable range of lift coefficients. The profile drag was reduced to one-half: $c_{d_{\infty/min.}} = 0.0023$ at $Re = 2.4 \times 10^6$ with suction (including the power absorbed for suction) as against $c_{d_{\infty/min.}} = 0.0048$ at $Re = 2 \times 10^6$ without suction. The range of c_l-values with low drag coefficients was more than doubled, and an optimum gliding angle of the airfoil $\epsilon_{\infty/opt.} = 1/200$ was obtained. With moderate deflections of a small trailing-edge flap ($c_F = 0.108c$) a favorable envelope of the polars, as well as an optimum gliding angle of the airfoil $\epsilon_{\infty/opt.} = 1/250$, was reached.

Loads on a Supersonic Wing Striking a Sharp-Edged Gust

By

M. A. Biot

Cornell Aeronautical Laboratory

A calculation of the chordwise lift distribution, total lift, and moment on a two-dimensional wing striking a sharp-edged gust at supersonic speed. A direct solution is established by considering a distribution of sources in a fluid at rest. An alternate method using Busemann's conical flow is also shown to be applicable. The time history of the total lift and mid-chord moment is discussed. It is shown that the total lift increases with time and reaches a maximum that corresponds to the steady-state phase of the flow. The mid-chord moment goes through a maximum independent of the Mach Number if the latter value is larger than $4/\pi$ while this maximum can become infinite for a range of Mach Numbers between $4/\pi$ and 1.

Base Pressures at Supersonic Velocities

By

Freeman K. Hill and Ralph A. Alpher

Applied Physics Laboratory, The Johns Hopkins University

Results are given of flight tests in which base pressures were directly measured in the range of Mach Numbers $0.8 < M < 2.5$. The base pressure coefficient, p_b/q, was found to be nearly constant for $1.2 < M < 1.6$ and then to decrease in absolute magnitude with increasing Mach Number. The values of p_b/q appear to be significantly larger in absolute value than were obtained from wind-tunnel tests at $M = 1.73$ on a model geometrically identical to one of the free-flight test vehicles and from wind-tunnel measurements on other models. However, all the wind-tunnel measurements were at Reynolds Numbers considerably lower than those in the flight tests, the latter being of the order of 2×10^7 to 1×10^8 at $M = 1.6$. This suggests that at supersonic velocities there may be a significant scale effect on base pressure. The distribution of pressure over the base was found to be essentially constant. No dependence of base pressure on body length was found in free flight and only a slight dependence on angle of attack. The functional dependence of base-pressure coefficient on the parameter's Mach Number, Reynolds Number, body length, position on the base, and body angle of attack is given in graphical form.

I.A.S. National Meeting Schedule

Fourth Annual Flight Propulsion Meeting—Hotel Carter, Cleveland—March 18

Sixth Personal Aircraft Meeting—Hotel Allis, Wichita, Kan.—April 28–29

Second Joint I.A.S.-R.Ae.S. Conference—New York—May 24–27

Annual Summer Meeting—Los Angeles—July 20–21

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All correspondence should be addressed to The Meetings Committee, Institute of the Aeronautical Sciences, 2 East 64th Street, New York 21, N.Y.

I.A.S. Preprints

Preprints of 1948 Meeting Papers Currently Available

No.

117 N.A.C.A. Investigation of Gas-Turbine Blade Cooling—H. Ellerbrock, Flight Propulsion Research Laboratory, N.A.C.A.

118 Problems of Gas-Turbine Propeller Combinations—Frank W. Davis, Assistant Chief Engineer, Consolidated Vultee Aircraft Corporation

123 Dynamic Lateral Stability As Influenced by Mass Distribution—Leonard Sternfield and Marion O. McKinney, Jr., Stability Research Division, Langley Memorial Aeronautical Laboratory, N.A.C.A.

130 The Boundary Layer of Yawed Infinite Wings—J. M. Wild, Graduate School of Aeronautical Engineering, Cornell University

131 Linearized Theory of Supersonic Control Surfaces—P. A. Lagerstrom, Assistant Professor, Guggenheim Aeronautical Laboratory, California Institute of Technology, and Martha E. Graham, Douglas Aircraft Company, Inc.

134 The Transient Reaction of a Two-Dimensional Wing at Supersonic Speed Due to Change in Angle of Attack—Chieh-Chien Chang, Associate Professor, Department of Aeronautics, The Johns Hopkins University

136 Stability and Control of Supersonic Aircraft—A. F. Donovan, A. H. Flax, and H. A. Cheilek, Cornell Aeronautical Laboratory

137 Experimental Study of Cooling by Injection of a Fluid Through a Porous Material—Pol Duwez and H. L. Wheeler, Jr., Jet Propulsion Laboratory, California Institute of Technology

138 The Flow of a Perfect Fluid Through an Axial Turbomachine with Prescribed Blade Loading—Frank E. Marble, National Research Council Predoctoral Fellow, Guggenheim Aeronautical Laboratory, California Institute of Technology

139 Service Experience with Turbojets—J. W. Bailey, Head, Engineering Services, Allison Division, General Motors Corporation

140 An Evaluation of Engine Design Compromises—Neil Burgess, Aircraft Gas Turbine Division, General Electric Company

141 Layout and Preliminary Design Problems—Milton U. Clauser, Chief, Mechanics Section, Douglas Aircraft Company, Inc.

142 Air Inlets and Nacelles—William J. Blatz, Project Aerodynamicist, McDonnell Aircraft Corporation

No.

143 Design of Turbojet Exhaust Systems—Herbert C. Towle, Jr., Principal Thermodynamicist, Republic Aviation Corporation

144 Accessory Equipment in Turbojet Installations—F. H. Sharp, Assistant Project Engineer, Consolidated Vultee Aircraft Corporation

145 The Four-Stroke Spark Ignition Compound Engine—LeRoy V. Humble and Cecile G. Martin, N.A.C.A.

146 The Two-Stroke Compression Ignition Compound Engine—Arnold E. Biermann and Max J. Tauschek, N.A.C.A.

150 Application of Simultaneous Equation Machines to Aircraft Structure and Flutter Problems—P. A. Dennis, Chief, Engineering Laboratories, and D. G. Dill, Research Engineer, Douglas Aircraft Company, Inc.

151 Shear Stress Concentration and Moment Reduction Factors for Reinforced Monocoque Cylinders Subjected to Concentrated Radial Loads—N. J. Hoff, Vito L. Salerno, and Bruno A. Boley, Polytechnic Institute of Brooklyn

152 Principles of Structural Design for Minimum Weight—F. R. Shanley, Consulting Engineer, Lecturer, University of California (L.A.)

153 The Application of Metallurgy to Aircraft Design—Leo Schapiro, Metallurgical Engineer, Testing Division, Douglas Aircraft Company, Inc.

157 Testing of Jet Engines Under Simulated Air-Speed and Altitude Conditions—J. F. Manildi, University of California, Department of Engineering, G. M. Giannini and Company, Inc.

159 Flight and Tunnel Test Research on Boundary-Layer Control—H. B. Dickinson, Flight Test Supervisor, Lockheed Aircraft Corporation

160 Design and Operation of a 12" Supersonic Wind Tunnel—Allen E. Puckett, California Institute of Technology

161 Recent NACA Research on High Length-Beam Ratio Hulls—Arthur W. Carter, Hydrodynamics Division, Langley Memorial Aeronautical Laboratory, National Advisory Committee for Aeronautics

162 Some Aeroelastic Properties of Swept Wings—S. I. Pai and W. R. Sears, Cornell University

163 The Ultimate Performance Sailplane—August Raspet, Research Director, Aerophysics Institute, Inc.

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STURGESS CABLE TENSION REGULATORS

While some means of maintaining a constant tension in aircraft control cables has long been sought, the need for such a device has become urgent with the advent of faster, higher ceiling, and larger type aircraft which magnify the adverse effects of temperature variation, structure deflections, and control system friction.

Sturgess Cable Tension Regulators are the result of nine years of development and test work in which aircraft manufacturers and the air forces have given splendid co-operation. They are light weight, self-contained mechanical units—non-hydraulic, non-electric. The simple locking mechanism, being integrally inter-connected to both sides of the cable system, prevents any phase displacement between the driven and driving ends of the control system.

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THE REGULATING PROBLEM:

When first approached nine years ago, the regulating problem was considered only to be the simple problem of compensating for the effect of change of temperature upon the skin of the airframe as compared with the effect upon the steel control cables. While this is still a major compensating requirement, heavier wing loadings on high speed aircraft, pressurized cabins, and heating systems have brought other factors to a magnitude requiring major consideration.

THERMAL FACTORS which require compensation are:

(a) Differences in expansion of cable and airframe over the full range of outside temperatures.
(b) Temperature lag of the cables in following the change in airframe temperature, under a rapid temperature change of the outside air.
(c) The effect of cabin heating or adjacent heating ducts causing cable temperatures to be higher than airframe temperatures. This is particularly important where insulation separates the airframe from the cables.

MECHANICAL FACTORS which militate against constant control cable tension are:

(a) Flexure of aircraft structure when cable run does not coincide with neutral axis of surrounding airframe.
(b) Distortion of aircraft structure caused by weight and placement of cargo, pressure cabins, etc.
(c) Wear in pulleys and cable.
(d) Permanent deflection in parts of control system due to wear and overstress.

Properly designed and installed Cable Tension Regulators assure constant ease of control and INSTANT RIGID RESPONSE to pilot action by maintaining within close limits, the ORIGINAL RIG LOAD, and CONSEQUENTLY FRICTION, of the control system.

IMPROVE SAFETY in FLIGHT

Uniform cable tension and therefore relatively constant friction in a control system cannot be over-emphasized, for changes in control system friction can completely mask the stick forces and thereby cause severe differences in pilot sensitivity. This applies equally well to systems with or without power boost.

Sturgess Cable Tension Regulators OFFER THE FOLLOWING DEFINITE ADVANTAGES in the handling of aircraft:

(1) They greatly IMPROVE THE STABILITY AND FLYING CHARACTERISTICS of the airplane for the following reasons:
  (a) They prevent slack cables and erratic control under conditions of extreme cold.
  (b) They prevent increased tension and friction in cables under conditions of high temperature.
  (c) They prevent over-taut and over-loose cables under conditions of structure distortion caused by heavy loads, concentrated cargo placement, pressure cabins, etc.
  (d) They make possible the use of greatly reduced rigged tensions, with consequent increased ease of handling. Low friction characteristics increase pilot feel and allow for an increase in aerodynamic balance of control surface if desired.
  (e) Uniform tension and friction under all conditions of flight are particularly important in high speed flight.

SAVE MAINTENANCE and INSPECTION TIME

(2) They greatly REDUCE SERVICE REQUIREMENTS on control systems because:
  (a) They ELIMINATE the necessity of cable tension adjustments for different areas of operation, or climatic conditions.
  (b) They decrease pulley, pin and cable wear and increase their life.
  (c) They permit rigging of cables at any hour of day or night under any temperature conditions, with assurance that tensions will remain as rigged.

GENERAL PRINCIPLE OF CONSTRUCTION AND OPERATION OF REGULATOR

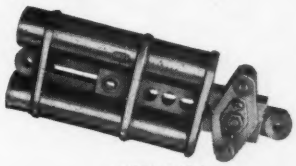
Sturgess Cable Tension Regulators are designed for interconnection between the two sides of a cable system and their operation is governed by the relative or differential tension between the two cables.

Essentially the regulators consist of (A) one or more compression springs introducing a tension equal to the desired rig load of the cable system and, (B) a locking mechanism which allows the springs to exert their force in the system only when the cable system is in neutral, i.e., tension on the two cables is equal. When the control column is in a neutral position where the tension on each cable of a control system is the same, the tension regulator spring is effective on the system and maintains the original rigged load on the cables, compensating for any changes that may have occurred due to temperature, cable stretch or other mechanical variation that might occur in the system. But as soon as any control load is applied in either direction by the pilot or control surface, the regulator locks and gives the pilot rigid control. EACH TIME, HOWEVER, THE CONTROL COLUMN PASSES THROUGH THE NEUTRAL POSITION THE RIGGED LOAD IS RESET, NO MATTER HOW RAPIDLY THIS ACTION MAY TAKE PLACE. The entire mechanism is simple, devoid of valves, packing glands, and similar points of possible trouble.

TYPES OF REGULATORS

Sturgess Cable Tension Regulators are manufactured in two general types.

(1) Standard units, designed for installation on existing control quadrants, sectors or drums, or which can be mounted on stationary structure to move pulleys over which the cables run. Included in this type is the R-72-B Regulator.
(2) Built In Regulators, a more recent development, in which the regulating mechanism is designed as an integral part of a quadrant, sector, or drum, mounting at either end of the control system. Shown, as one example, is R-80.



TYPE R-72-B

Incorporates two telescopic tubes for rig load springs mounted one on each side of main frame brake leaf assembly. This affords a flat design for easy installation in confined areas.

MODEL R-80 QUADRANT

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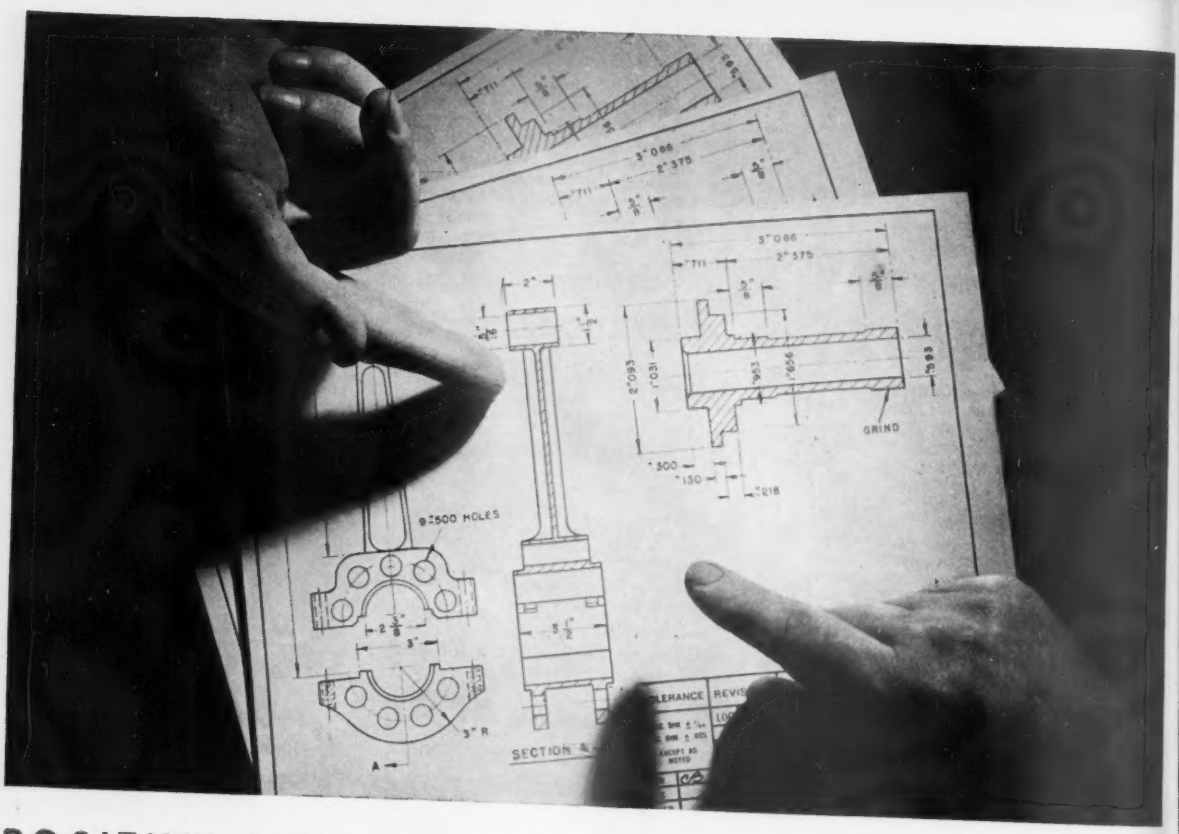

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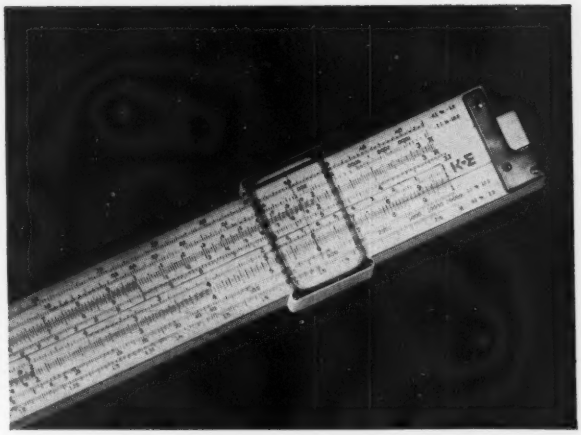

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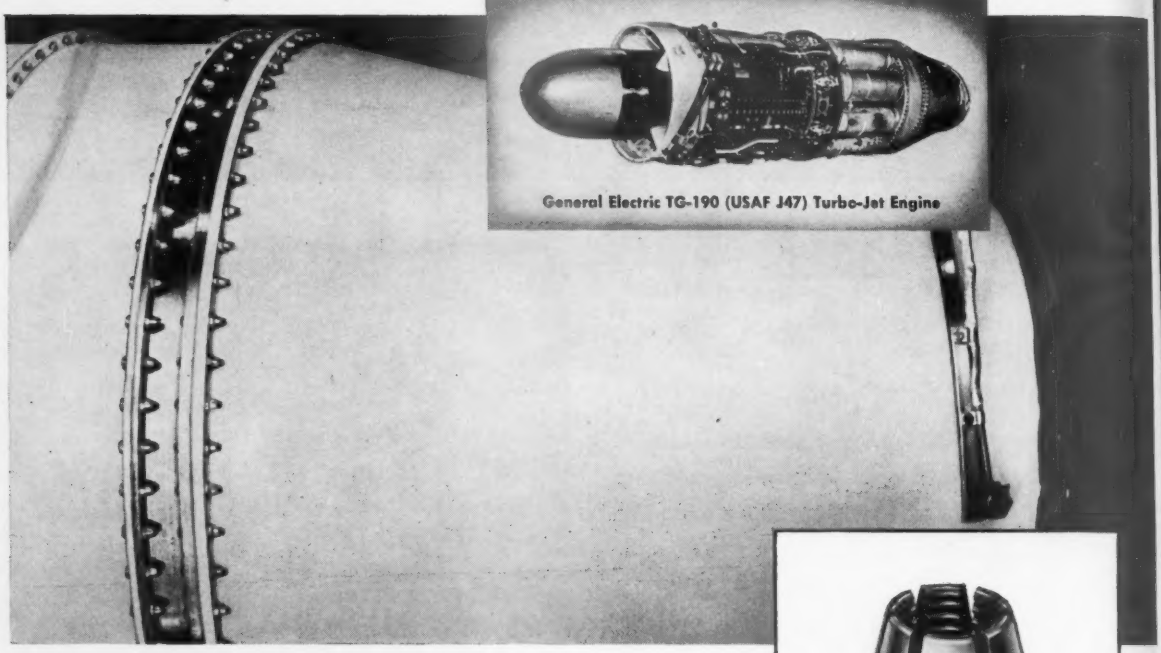

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Aeronautical Reviews

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The abstracts are classified according to the Standard Aeronautical Indexing System. Numbers in parentheses indicate the position of the Division Headings in the numerical arrangement. Headings marked by an asterisk have not yet been established by the S.A.I.S.

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Reviewed by Maurice H. Smith, Institute of the Aeronautical Sciences

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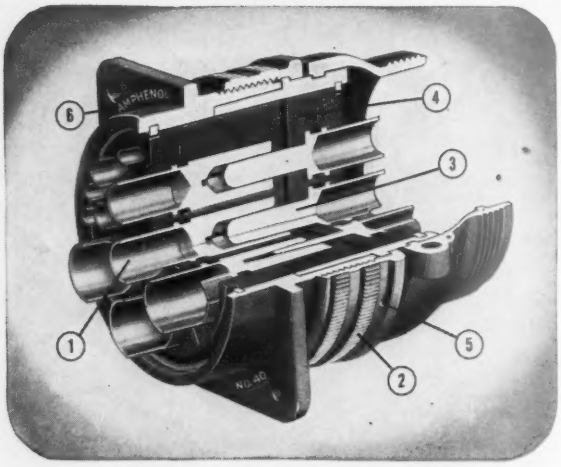

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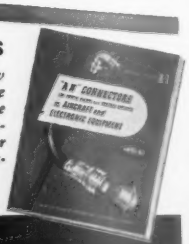

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Aerodynamics (2)

BOUNDARY LAYER

Exploratory Wind-Tunnel Investigation of the Effectiveness of Area Suction in Eliminating Leading-Edge Separation Over an NACA 64_1A212 Airfoil. Robert J. Nuber and James R. Needham, Jr. *U.S., N.A.C.A., Technical Note No. 1741,* November, 1948. 27 pp., illus., figs. 2 references.

An exploratory wind-tunnel investigation of an NACA 64_1A212 airfoil with a permeable nose of sintered bronze was made to determine the effectiveness of area suction in controlling leading-edge separation. The effect of variations of the relative extent of permeable surface area was investigated. The results indicate that not only was leading-edge separation prevented but turbulent separation moving forward from the trailing edge was delayed. Maximum effectiveness was obtained at a flow coefficient of 0.0018 with the upper surface porous to 4.5 per cent chord.

CONTROL SURFACES

Wind-Tunnel Investigation at Low Speed of the Lateral Control Characteristics of Ailerons Having Three Spans and Three Trailing-Edge Angles on a Semispan Wing Model. Leslie E. Schneiter and Rodger L. Naeseth. *U.S., N.A.C.A., Technical Note No. 1738,* November, 1948. 52 pp., figs. 3 references.

An investigation of the low-speed lateral control characteristics of an essentially unswept wing, equipped with sealed 20 per cent chord plain ailerons having spans of 0.954, 0.583, and 0.294 per cent of a full-span aileron, each with trailing-edge angles of 6°, 14°, and 25°. In tests with the ailerons unsealed, they were used as lift flaps having spans of 0.954 and 0.660 per cent of a full-span flap. In general, the existing theoretical method for predicting the slope of the curve of rolling-moment coefficient with aileron deflection for various spans of aileron, gave satisfactory agreement with the experimental results for ailerons having trailing-edge of 6° and 14°. The agreement between the experimental and theoretical values for this coefficient was poor for the ailerons with a trailing-edge angle of 25°. The existing empirical relationships for predicting the incremental change in slope of the curves of aileron hinge-moment coefficient, with both aileron deflection and with wing angle of attack resulting from an incremental change in the aileron trailing-edge angle, may be used satisfactorily to estimate the effects of variation of the control-surface trailing-edge angle, regardless of the span of the control surface.

Evaluation of a Fixed Spoiler as a Gust Alleviator. Harry C. Mickleboro. *U.S., N.A.C.A., Technical Note No. 1753,* November, 1948. 14 pp., illus., figs. 5 references.

The results of an investigation made in the Langley gust tunnel to determine the effectiveness of a fixed spoiler as a gust alleviator show that approximately the same maximum acceleration is experienced by the model with or without the spoiler in a sharp-edge gust. In a gust with a gradient distance of 12 chords, the use of the spoilers resulted in a 30 per cent reduction of the maximum acceleration increment produced without spoilers.

FLUID MECHANICS & AERODYNAMIC THEORY

An Investigation of the Exact Solutions of the Linearized Equations for the Flow Past Conical Bodies. O. LaPorte and R. C. F. Bartels. *University of Michigan, Engineering Research Institute, Bumblebee Report No. 75,* February, 1948. 78 pp., figs. 14 references.

A method of determining the solution of the equations formulated by Busemann for the linearized flow past a conical body when the flow is conical. The solution that is obtained satisfies the precise boundary conditions along the surface of the body. A flow is obtained for which the surface is an actual stream surface. The components of the velocity of the flow are determined by a single analytic function of a complex variable, which plays a role comparable to that of the complex velocity potential in the theory of steady irrotational motion of an incompressible, ideal fluid. The general problem of conical flow thus formulated is treated analytically according to the theory of functions of a complex variable by techniques utilizing conformal mapping. In the treatment of the arrow wing, the boundary conditions are shown to be insufficient to determine the conical flow past the wing. On the other hand, the addition of a supplementary condition—that the lift coefficient of the wing be finite—suffices to

determine the flow uniquely. The work on the conical flow past an elliptic cone indicates that the incompleteness of the boundary conditions, in the case of the arrow wing, springs from the singularities of the surface at the wing edges, because those boundary conditions, in the case of the arrow wing, spring from the singularities of the surface at the wing edges, because those boundary conditions are sufficient to determine a unique conical flow past an elliptic cone without edge, which has a finite velocity at every point of the field.

The Theory of the Impact Tube at Low Pressures. P. L. Chambré and S. A. Schaaf. *Journal of the Aeronautical Sciences*, Vol. 8, No. 12, December, 1948, pp. 735–737, figs. 4 references.

In order to obtain a theoretical basis for the interpretation of impact-tube measurements taken in a high-velocity gas stream of such low pressure that the mean free path is larger than the impact tube diameter, a formula is derived which relates the free-stream Mach Number and the ratio of the product of pressure and density in the free stream to that in a reservoir located at the end of the impact tube. Unlike the Rayleigh formula, which is based on continuum theory, this expression contains, as a parameter, the geometry of the tube and yields Mach Number determinations that differ greatly from those obtained with the Rayleigh formula.

Note on the Efficiency of Adiabatic Shock. A. W. Morley. *College of Aeronautics, Cranfield, England, Report No. 22*, September, 1948. 10 pp., figs.

Calculations of the efficiency of adiabatic shock in air, when the efficiency is defined as the ratio of the work used to compress the air in the shock wave from the inlet static to the outlet total head pressure to the work required if the compression were isentropic. In intakes of propulsive units at supersonic flight, it is seen that, with oblique shock, the efficiency is nearly 100 per cent until the flight Mach Number reaches about 1.8, after which an appreciable decrease occurs. Although the ratio of the pressure behind the shock to the pressure ahead of the shock is lower, the same pressure ratio can be obtained at a higher efficiency with oblique shock than with normal shock.

An Investigation of the Detached Shock in Front of a Body of Revolution. John Dugundji. *Journal of the Aeronautical Sciences*, Vol. 8, No. 12, December, 1948, pp. 699–705, figs. 3 references.

An investigation of the velocity distribution between a body of revolution in a uniform supersonic stream and the detached shock that forms in front of it, in order to find the relations that exist between the curvature of the shock wave, the distance from the shock to the body along the axis of symmetry, and the curvature of the body nose. The values that are obtained for the product of shock curvature and distance from the body agree reasonably well with the experimental values of Charters and Ladenburg, Van Voorhis, and Winkler.

Spectrum of Locally Isotropic Turbulence. Leslie S. G. Kovasznay. *Journal of the Aeronautical Sciences*, Vol. 8, No. 12, December, 1948, pp. 745–753, figs. 15 references.

A theory to describe the spectrum of locally isotropic turbulence, which encompasses both the nonviscous region, where Kolmogoroff's second similarity hypothesis may apply, and the viscous region, where dissipation is important. The spectrum is identical with the $-5/3$ power law in the nonviscous range, but at the viscous high-frequency end it falls off rapidly. The correlation coefficients agree with Kolmogoroff's predictions for both small r and for large r and give explicit results in the intermediate range. The only free constant in the present theory is a Reynolds Number that corresponds to the smallest eddies. Comparison with energy spectrum and correlation measurements shows that, for eddies that are large compared with dissipative eddies, the agreements and discrepancies with experiment are the same as for Kolmogoroff's theory. Agreement with experiments is satisfactory but could be greatly improved by an appropriate theory for the mechanism of energy distribution at the low-frequency end of the spectrum.

INTERNAL FLOW

Performance of Conical Jet Nozzles in Terms of Flow and Velocity Coefficients. R. E. Grey and H. D. Wilsted. *U.S., N.A.C.A., Technical Note No. 1757*, November, 1948. 32 pp., diagr., figs. 1 reference.

Performance characteristics of conical nozzles over a range of pressure ratios from 1.0 to 2.8, cone half-angles from 5° to 90°, and outlet-inlet diameter ratios from 0.50 to 0.91 (inlet diameters, 5.0 in.) were investigated. The flow coefficients of the conical nozzles were dependent on cone half-angle, outlet-inlet diameter ratio, and pressure ratio. The velocity coefficients were essentially independent of cone half-angle and outlet-inlet diameter ratio and of pressure ratio below a value of 2.0. The variation of performance of several nozzles selected for the same performance at a particular design condition was proportional to the ratio of their flow coefficients.

The Efficiency of Adiabatic Expansion. A. W. Morley. *College of Aeronautics, Cranfield, England, Report No. 21*, September, 1948. 13 pp., figs. 6 references.

The efficiency of the adiabatic process is defined in terms of the fraction of the enthalpy increment, which is reconverted into heat by the frictional effects. The general relationships that are developed from this definition are used to study the choking mass flow through a turbine nozzle.

THERMO-AERODYNAMICS

Bibliography of Aerodynamic Heating and Related Subjects; An Addendum to Army Air Forces Technical Report No. 5632. R. G. DuBois and J. Kelley, Jr. *U.S., Army Air Forces, Technical Report No. 5633 (ATI No. 13467)*, September 10, 1947. 97 pp.

Contains about 500 references to material published prior to July, 1947, which were used in the preparation of a design manual at the University of California. A brief abstract or annotation is provided for most of the items, and an English translation is given for the foreign-language titles. Arrangement is by subject, with the references listed alphabetically by author under subsection, as follows: Aerodynamic Heating, general, boundary layer; Atmospheric Properties; Convective Heat Transfer, general, high speed, thermodynamics; Fluid Mechanics, general, boundary layer, instruments, pressure distribution, subsonic, supersonic; Gases, Properties of; Radiation, general, atmosphere, instruments, gaseous.

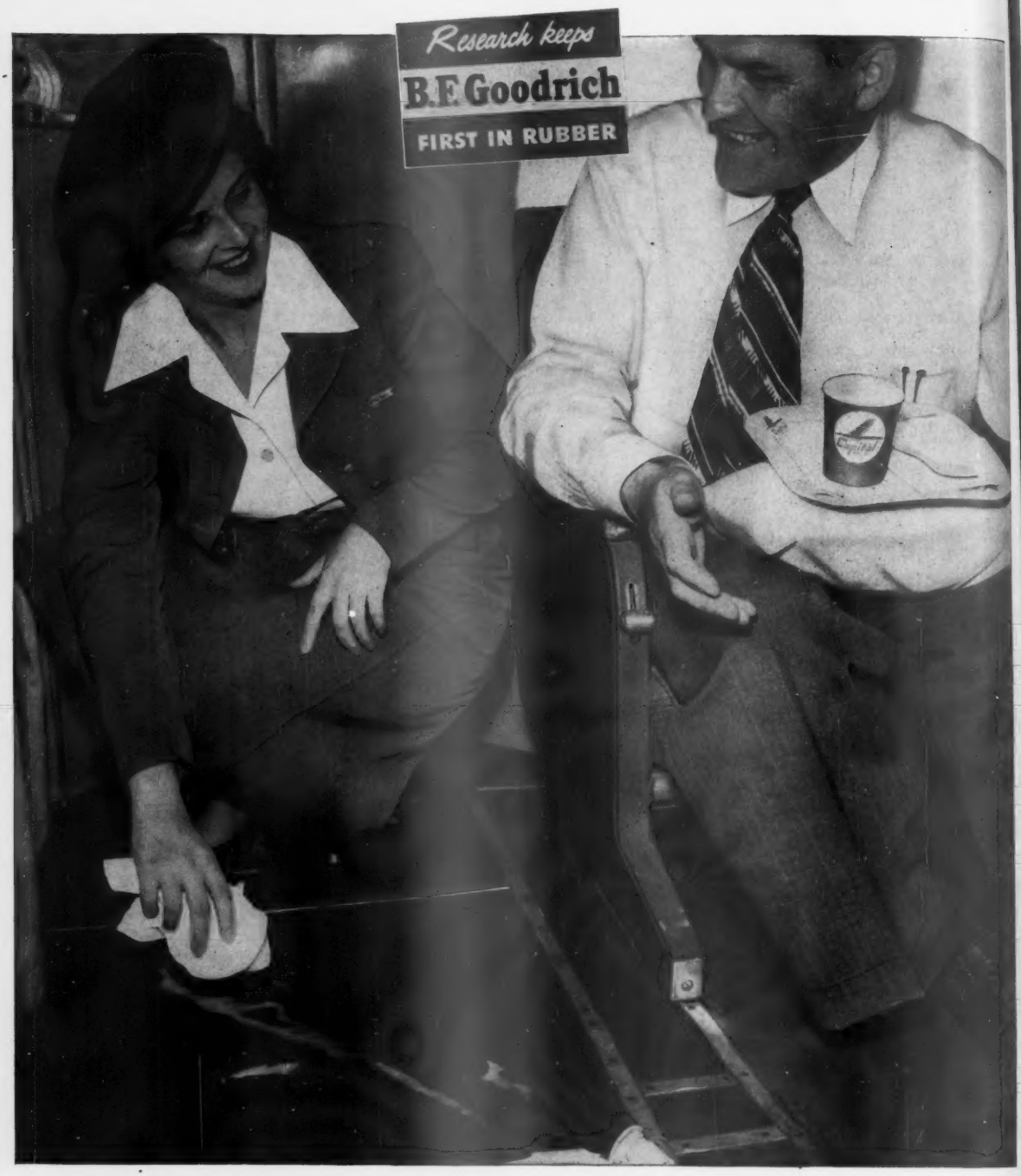
Airplane Design & Description (10)

Focke Wulf Designing Offices and General Management, Bad Eilsen. V. W. Peterson, G. B. Stephens, and P. Cherney. *Combined Intelligence Objectives Sub-Committee, Item No. 25, File No. 26-6.* 83 pp., figs. 8 references. British Information Services, New York. $2.65.

Summaries of the results of interrogation of the principal personnel of the Focke-Wulf installation at Bad Eilsen. Gives organization of the firm; annual production figures from 1937 to 1944; description of facilities and physical layout of the plant; personal histories of the people interrogated; current design projects; performance, armament, and power-plant specifications for fighter, ground interceptor, and fighter-bomber versions of the FW-190 and 152; and a review of the status of jet aircraft development in Germany. Research undertaken by Focke-Wulf included work on the aerodynamics of jet aircraft, athodyd power plants, laminar-flow airfoils, sonic and supersonic flow, compressibility, sweepback, and wind-tunnel data correction at high Mach Numbers.

Aviation History—1903 to 1960. John K. Northrop. (National Air Council Lecture Series.) *U.S., Library of Congress, Information Office, Press Release No. 521*, November 3, 1948. 23 pp., figs. (An address.)

The progressive changes in the structure and configuration of air frames have resulted in increased aerodynamic efficiency and made air speeds in excess of 600 m.p.h. possible. Initially, the internal combustion engine was chosen for aircraft power plants because of its low weight-power ratio. Recent development of the internal-combustion turbine engine has produced the turbojet and the turboprop power plants, which have proved more efficient than the reciprocating engine at high subsonic and supersonic speeds. Increased speeds, increased altitudes, and increased power have made aircraft proportionately more costly to develop and manufacture, because they have become highly complex machines and require accessory systems and equipment for their operation. In the next 15 years the long-range bomber will be replaced by the guided missile; the fighter airplane, by a ground-to-air interceptor. Manned aircraft will probably be relegated, in military operations, to the transportation of cargo and personnel. It can be expected that aircraft will operate at speeds of about 500 m.p.h. and will be powered by turboprop engines. Because of the inherent costliness of high power at supersonic speeds, the



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turbojet will be restricted in its use by the dictates of military expediency. Nuclear energy may be adapted to aircraft propulsion, but it will probably require aircraft structures so costly that it will find only limited application.

Jets Are Not Simpler. *Flying*, Vol. 43, No. 6, December, 1948, pp. 30, 31, diagrs. Comparison of the instrument panels of the North American XFJ-1 Fury jet fighter and the F-51H Mustang.

American Piston-Engined Bombers (Boeing B-29 and B-50, Convair B-36, and Northrop B-35). *Flight*, Vol. 54, No. 2078, October 21, 1948, pp. 481–484, illus.

Czech Trainer (Zlin 26) and Sailplane (Lunak L.102). *Flight*, Vol. 54, No. 2080, November 4, 1948, p. 553, illus.

New Italian Aircraft (S.I.A.I.-Marchetti SM.101, Piaggio P.136 Feeder-Line Transports and the Macchi MB.308 Seaplane). *The Aeroplane*, Vol. 75, No. 1952, November 5, 1948, p. 590, illus.

Three Point Précis. *Aeronautics*, Vol. 19, No. 6, November, 1948, pp. 27–41, illus., diagrs. Descriptions, specifications, three-view sketches, and illustrations of a detail feature of each of 47 British airplanes, including four rotating wing aircraft.

British and Canadian Jets (Canadian Avro C.102 Transport, Avro Tudor 8 Transport, and the Hawker N 7/46 Fighter). *Aero Digest*, Vol. 57, No. 5, November, 1948, pp. 30, 102, illus.

British Bombers—Present, Future. *Aviation Week*, Vol. 49, No. 19, November 8, 1948, p. 15.

Atlas Cut Production Costs for Their New Light Aircraft (Atlas H-10). *Shell Aviation News*, No. 124, October, 1948, p. 23, illus.

Details on Canada's Jet Fighter (Avro Canada XC-100). *Aviation Week*, Vol. 49, No. 19, November 8, 1948, p. 16, illus.

First Jet Transport, the (Canadian) Avro XC-102. *Aviation Week*, Vol. 49, No. 18, November 1, 1948, pp. 18, 20, 21, illus.

(Convair) XP5Y-1: Latest Navy Flying Boat. *Aviation Week*, Vol. 49, No. 18, November 1, 1948, pp. 13, 14, illus.

The de Havilland Dove Ambulance (D.H. 104 Dove). *de Havilland Gazette*, No. 47, October, 1948, pp. 10, 11, illus.

The (de Havilland) Vampire (Mks. 5, 6, and 50) Ground Attack Fighter. *The Aeroplane*, Vol. 75, No. 1951, October 29, 1948, p. 553, diagr.

Ground, Attack Vampires: Ground Attack (de Havilland) Vampires (Mks. 5, 6, and 50). *Flight*, Vol. 54, No. 2079, October 28, 1948, p. 526, diagrs.

Vampire (de Havilland Fighter) War Potential in 1948. *The Aeroplane*, Vol. 75, No. 1952, November 5, 1948, pp. 586, 587, illus., figs. Includes charts for comparison of the performance of different models of the Vampire.

A Strategic Transport by Douglas (C-124A All-Purpose Transport). *Plane Facts*, Vol. 5, No. 10, October, 1948, pp. 7, 8, 29, illus.

Fokker To-Day; Holland's Reconstructed Aircraft Industry; The New Combined Company; Four New Trainers. Maurice A. Smith. *Flight*, Vol. 54, No. 2079, October 28, 1948, pp. 511–515, 525, illus.

The Latest Hawker (N. 7/46 Naval Fighter). *Aircraft & Airport*, Vol. 10, No. 10, October, 1948, p. 36, illus.

Designing the F-80 (Lockheed Shooting Star). *Flying*, Vol. 43, No. 6, December, 1948, pp. 33, 34, 65, 66, illus., diagr.

Lockheed Constitution (XR 60-1). *Shell Aviation News*, No. 124, October, 1948, p. 24, illus.

Mooney M-18 (Personal Airplane). Max Karant. *Flying*, Vol. 43, No. 6, December, 1948, pp. 38, 39, 73–76, illus.

American Choice (North American F-86 Fighter). *Flight*, Vol. 54, No. 2082, November 18, 1948, pp. 592, 593, illus., diagr.

Northrop C-125 (Raider) Based on Pioneer (Commercial Transport). Robert McLarren. *Aviation Week*, Vol. 49, No. 19, November 8, 1948, pp. 21, 22, 25, 26, illus.

Flying the Prestwick Pioneer. R. G. Worcester. *The Aeroplane*, Vol. 75, No. 1951, October 29, 1948, pp. 559–561, illus., figs.

Sponson Tribian (British 3-4 Seater Amphibian). *Shell Aviation News*, No. 123, September, 1948, p. 24, illus., diagr.

The (Vickers) Supermarine 'Attacker'; Outstanding British Fighter. *Aviation Week*, Vol. 49, No. 19, November 8, 1948, p. 19, illus.

LANDING GEAR

Smaller Tires and Lighter, More Efficient Brakes for B-29 Bomber. *Automotive Industries*, Vol. 99, No. 9, November 1, 1948, pp. 41, 66, 68, illus.

The multiple-wheel landing gear developed by the Bendix Aviation Corporation for the B-29 bomber has been designed for 56- by 16-in. tires. In addition to a greater blow-out safety factor, more efficient braking, reduced size, and greater load capacity, the installation provides the aircraft with a footprint loading that approaches a loading appropriate for military landing strips and effects a saving of 36.4 per cent of the weight of the 65-in. tire landing gear with which the bomber was previously equipped.

Metallurgical Examination of Landing Gear Strut, Landing Wheel and Tail Wheel Strut Assembly From Japanese Aircraft "Betty." C. A. Reichelderfer, J. M. Blalock, and others. *Gt. Brit., British Intelligence Objectives Sub-Committee, Report No. B.I.O.S./J.A.P./P.R./1482*, July 24, 1944. 23 pp., figs. British Information Services, New York. $1.45.

Flying Runways. *Shell Aviation News*, No. 123, September, 1948, pp. 12, 13, illus. Caterpillar-track tricycle landing gear for the Fairchild C-82 Packet decreases the ground pressure of the landing gear by one-third; weight is increased by 1,075 lbs.

Report on German Work Relevant to the Interaction Between Tyres, Vehicles and Road Surfaces. W. J. O. Scott, G. W. Calvert, and J. B. Edwardes. *Gt. Brit., British Intelligence Objectives Sub-Committee, Final Report No. 1717, Item No. 22.* 86 pp., illus., diagrs., figs. 36 references. British Information Services, New York. $2.75.

Airplane Operation*

Flying the Jet. Harland Wilson. *Flying*, Vol. 43, No. 6, December, 1948, pp. 28, 29, 76, 77, illus.

Operating Aircraft in Cold Weather. G. W. Wilson and E. P. Bridgland. *The Aeroplane*, Vol. 75, No. 1951, October 29, 1948, p. 552. (Summary of a paper.)

Curing Those Ups and Downs. John R. Hoyt. *Flying*, Vol. 43, No. 6, December, 1948, pp. 42, 63–65. Constant-altitude and variable-altitude cross-country flight.

Ground Running Checks on the Tudor IV. A. W. J. Smith. *The Technical Instructor*, Vol. 3, No. 10, October, 1948, pp. 10, 11.

Airports & Airways (39)

Airport Financial Management. Leigh Fisher and Robert S. Einzig. *Aviation Maintenance & Operations*, Vol. 10, No. 6, November, 1948, p. 31.

Air Terminal Ground Traffic Problems. Robert Ramspeck. *Airports & Air Transportation*, Vol. 3, No. 65, November 1948, pp. 137, 138.

Draining Airfields by Capillary Attraction. Harold B. Pereira. *Airports & Air Transportation*, Vol. 3, No. 65, November, 1948, pp. 123–125, illus., diagr.

GE-AGA High-Intensity Runway Lighting. *General Electric Company, Apparatus Department, (Publication) No. GEA 4931a*, October, 1948. 16 pp., illus., diagrs., figs.

Airports of the World: Karachi (Pakistan), Gateway to the East. *Airports & Air Transportation*, Vol. 3, No. 65, November, 1948, pp. 127–130, illus.

All-Weather Flying (31)

ICE PREVENTION

Aircraft De-Icing at A.V.A., Göttingen. J. R. Leach and G. Brown. *Gt. Brit., British Intelligence Objectives Sub-Committee, Final Report No. 585, Item No. 27.* 13 pp., figs. British Information Services, New York. $0.55.

Meteorological stations, test facilities, and electrical and hot-air methods for deicing airfoils, propellers, windscreens, pitot heads, and engine air-intake ducts, developed at the Aerodynamische Versuchsanstalt, Göttingen, by the Institut für Kälteforschung.

De-Icing and De-Misting of Aircraft Windscreens; Investigation of German Electrically Heated Windows. T. R. Thomas and A. C. Waine. *Gt. Brit., British Intelligence Objectives Sub-Committee, Final Report No. 899, Nos. 25, 27.* 10 pp.,

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figs. British Information Services, New York. $0.35. Investigation of manufacturers of heated laminated plexiglas and safety-glass windshields and their electrical components. Extremely fine, closely spaced, parallel wires embedded in the interface serve as heating elements.

Atomic Energy (48)

Course in Nuclear Physics for Engineers, January 15–May 14, 1946. University of California. *U.S., Atomic Energy Commission, Document No. MDDC-1014,* June 1947 (Declassified January 28, 1947). 152 pp., diagrs., figs. Document Sales Agency, Atomic Energy Commission, P.O. Box 62, Oak Ridge, Tenn. $0.50.

Contents: The Cyclotron, R. L. Thornton. The Synchro-Cyclotron, E. M. McMillan. The Synchroton, E. M. McMillan. D. C. Magnet Design, W. M. Powell. The Linear Accelerator, W. K. H. Panofsky. Oscillators, K. L. MacKenzie. Van de Graaff Generator, C. M. Turner. Voltage, Current and Phase Relations on Transmission Lines, K. L. MacKenzie. Nuclear Physics, Carl Helmholz. Radioactivity, Carl Helmholz. The Interaction of Nuclear Radiation with Matter, Emilio Segrè. High Vacuum Practice, W. M. Brobeck. Particle Counting and Measurement, Clyde Wiegand. The Cloud Chamber and Cosmic Rays, W. M. Powell. Nuclear Fission, Carl Helmholz. Appendix: Summary of Conversion Factors and Equations Applying to Magnetic Accelerator, W. M. Brobeck.

Meteorological Equipment of the Hanford Engineer Works. P. W. Church and E. A. Gosline, Jr. *U.S., Atomic Energy Commission, Document No. MDDC-841,* April 17, 1947. 15 pp., illus. Document Sales Agency, Atomic Energy Commission, P.O. Box 62, Oak Ridge, Tenn. $0.10.

Some Engineering and Economic Aspects of Nuclear Energy. M. C. Leverett. *U.S., Atomic Energy Commission, Document No. MDDC-1304,* September 10, 1947. 11 pp., fig. (An address.) Document Sales Agency, Atomic Energy Commission, P.O. Box 62, Oak Ridge, Tenn. $0.10.

Metallurgy in the Development of Atomic Power. John Chipman. *U.S., Atomic Energy Commission, Document No. MDDC-539,* October, 1946 (Declassified November 25, 1946). 21 pp., figs. Document Sales Agency, Atomic Energy Commission, P.O. Box 62, Oak Ridge, Tenn. $0.10.

Atomic Bomb Engineering. A. C. Klein. *U.S., Manhattan Project, Document,* November 20, 1945. 38 pp. (An address.) Document Sales Agency, Atomic Energy Commission, P.O. Box 62, Oak Ridge, Tenn. Microfilm, $1.00; photostat, $3.00.

Atomic Power Engineering. F. C. Von der Lage. *U.S., Atomic Energy Commission, Document No. MDDC-792,* March, 1947 (Declassified March 31, 1947). 21 pp. Document Sales Agency, Atomic Energy Commission, P.O. Box 62, Oak Ridge, Tenn. $0.10. General job information on the work of an atomic-power engineer.

Developing a Giant's Special Skills; A Noted Physicist Outlines Possible Industrial Uses of Atomic Energy. Eugene P. Wigner. *The Pegasus,* Vol. 12, No. 11, November, 1948, pp. 11, 12, 16, figs.

Comfortization (23)

Report on Survey of Lighting Preferences of a Group of Naval Aviators in the XAM-2 Cockpit Mockup. Fred R. Brown. *U.S., Naval Air Material Center, Naval Air Experimental Station, Aeronautical Medical Equipment Laboratory, Report TED No. NAM EL 600, Part I,* October 20, 1948. 38 pp., illus. More than half the preferences were for a combination of indirect lighting with low-level floodlighting, because of the need for visibility of the control and indicating elements on the consoles.

Lubrication of Cabin-Pressurization & Air-Conditioning Systems. II. D. N. Harris. *Aero Digest,* Vol. 57, No. 5, November, 1948, pp. 63, 64, 66, 68, diagr., figs. The installations in the Douglas DC-6, Convair-Liner, and the Boeing 377 Stratocruiser.

Aircraft-Seat Testing. *Aircraft Production,* Vol. 10, No. 121, November, 1948, p. 365, illus. Techniques used by Consolidated Vultee Aircraft Corporation to evaluate aircraft seat materials.

Noise Problem Up to Industry. Alexander McSurely. *Aviation Week,* Vol. 49, No. 18, November 1, 1948, pp. 27, 28, illus.

The Aeronautical Research Foundation has reduced the noise of personal aircraft to a level, when flying at 100 ft. altitude, below that of automobile traffic. The Stinson Voyager 150 and the Piper Cub J-3 tandem trainer that underwent modification were fitted with four-bladed fixed-pitch propellers, reduction gearing, and exhaust mufflers.

Education & Training

Training B.O.A.C.'s Pilots for the Atlantic Services. Charles H. Pentland. *Shell Aviation News,* No. 124, October, 1948, pp. 7, 8, illus.

Reading Skills. M. L. Miller and Fred Couey. *Plane Facts,* Vol. 5, No. 10, October, 1948, pp. 11–13, 32. An investigation of the relation between reading skill and pilot training aptitude, and a description of methods used to increase rate of silent reading.

The de Havilland School of Flying, No. 1 Reserve Flying School—An Informal History of the First Quarter Century. *The de Havilland Aircraft Co., Ltd., Hatfield, Herts, Eng.,* November, 1948. 23 pp., illus.

How Jet Jockeys Are Made. John F. Loosbrock. *Popular Science Monthly,* Vol. 153, No. 6, December, 1948, pp. 109–114, illus, diagr. Jet pilot training at Williams Air Force Base.

Aviation Training in India; The New Dominion Trains Her Own Radio and Radar Staff. *The Aeroplane,* Vol. 75, No. 1952, November 5, 1948, pp. 591, 592, illus.

GI Flight Training—Where Does It Stand? *Aviation Maintenance & Operations,* Vol. 10, No. 6, November, 1948, p. 15. Statistics on the disposition by the Veterans' Administration of applications for flight training during July and August, 1948, under the Servicemen's Readjustment Act of 1944.

Electronics (3)

The Binaural Presentation of Guidance Data. J. Beneke. *Cornell Aeronautical Laboratory, Inc., Report No. OM-568-P-1,* October 5, 1948. 8 pp., diagrs. 8 references.

Because of the intermittent character of the guidance information obtained by a pilot from I.L.S. and G.C.A., which may cause his approach to degenerate into a series of long-period unstable oscillations about the desired path, the possibility was investigated of using the binaural direction-discriminating sense to convey guidance data to pilots. By connecting two amplifiers in push-pull and varying their relative bias, the resultant phase shift and variation in intensity between the earphones gave an apparent shift in the source of the sound from directly left to directly right. Vertical orientation was provided by using a signal consisting of two dots and a dash, in which the dots varied in pitch, while the dash remained constant.

Interrogation of Prof. Scherzer of the Bevollmächtigter für Hochfrequenztechnik. R. G. Friend, W. H. Maddison, and others. *Combined Intelligence Objectives Sub-Committee, Item No. 1, File No. 32–87.* 11 pp. British Information Services, New York. $0.35.

The status of German research in: radar camouflage by non-reflecting materials; centimeter-wave, beam-swinging aerials employing transparent dielectric materials susceptible to control by an external electric or magnetic field; magnetrons and light-house tubes; propagation of waves in the band between the infrared and 3 cm.; centimeter-wave receivers; jamming and antijamming measures; fire control radar; submarine radar; cm.-wave transmitters; and proximity fuses.

The I.T.T., Siemens, and Robert Bosch Organizations. Crainger, Holt, and others. *Combined Intelligence Subjectives Sub-Committee, Item No. 1, 7, 9, File No. 31-38.* 57 pp., figs. British Information Services, New York. $1.75.

Description of the facilities, work, and products of the laboratories of Lorenz A.G. at Landshut, Auerbach, and Falkenstein; units of the Siemens Organization at Lichtenfels, Rudolstadt, Erlangen, Asch, Pretzfeld, and München; the Robert Bosch A.G. plants at Stuttgart; and the Fernseh Grub H at Taufkirchen. Includes summary of work of Dr. Goldman of Lorenz A.G. in the development of electronic navigation-aid systems; a description of the time-modulation technique used in navigation instrument approach and control systems; report of an interview with Georg Siemens; and a description of television homing devices and associated control systems for missiles.

Performance talks

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"... among the most reliable pieces of equipment on our air freighters." ... Slick.

"... are giving reliable and economical performance on our Constellation Fleet" ... TWA.

"... have cut overhaul time in half and reduced off-schedule maintenance." ... Northwest.

"... their durability and simplicity of design mean less parts replacement and less man-hours to overhaul." ... National.

"... from both operational and maintenance viewpoints their service has been very satisfactory." ... Colonial.

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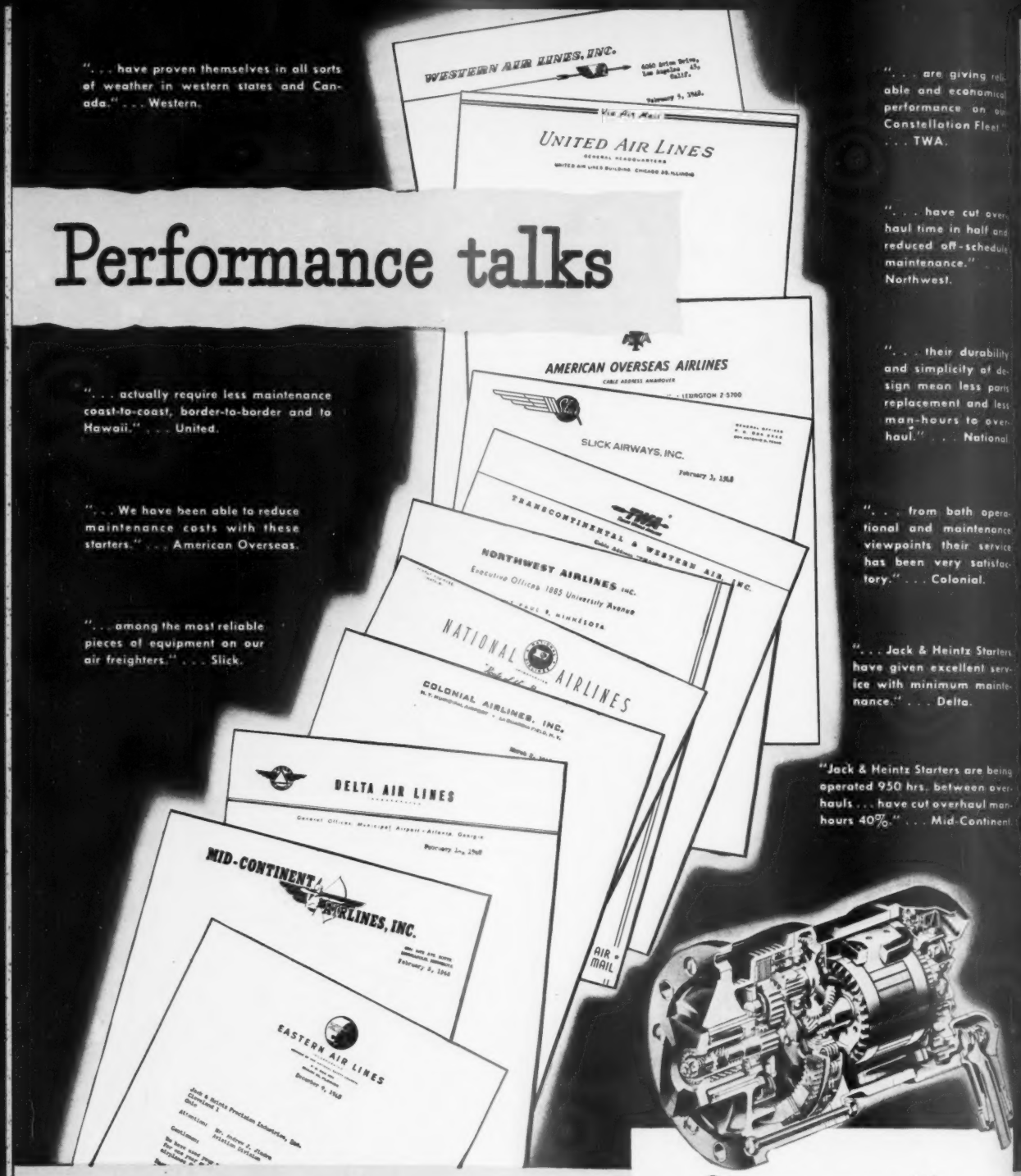

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Theory of Models of Electromagnetic Systems. George Sinclair. *Institute of Radio Engineers, Proceedings*, Vol. 36, No. 11, November, 1948, pp. 1364–1370, fig. 12 references.

A derivation of the conditions that an absolute model must satisfy both in order to simulate accurately the geometrical configurations of the lines of force in the fields of an electromagnetic system and in order to yield measurements that represent quantitatively those to be obtained from the full-scale system.

German Development of Modulator Valves for Radar Applications. H. W. Bahns and H. T. Ramsay. *Gt. Brit., British Intelligence Objectives Sub-Committee, Final Report No. 1746, Item No. 1.* 26 pp., fig. British Information Services, New York. $1.00.

German Radio Capacitors. S. J. Borgars. *Electronic Engineering*, Vol. 20, No. 249, November, 1948, pp. 355–357, diagrs., figs. 6 references.

Potentiometers for Computing Circuits. R. Wilson Williams. *Electronic Engineering*, Vol. 20, No. 249, November, 1948, pp. 358–360, figs. 2 references.

Engineering Practices & Aids (49)

The Bell Relay Computer. Franz L. Alt. *Instruments*, Vol. 21, No. 10, October, 1948, pp. 912, 913, illus.

Electronic Analogue Computers. I. David Fidelman. *Radio & Television News*, Vol. 40, No. 6, December, 1948, *Radio-Electronic Engineering*, pp. 3–6, 29, illus., diagrs., figs.

Equipment

Aircraft Accessory Systems. T. B. Holliday. *Product Engineering*, Vol. 14, No. 11, November, 1948, pp. 119–121, figs. A comparison of the efficiency and the weight penalty imposed by the source of power, the distribution system, linear and rotary actuators, the reservoir, in hydraulic, pneumatic, electrical, and combined aircraft accessory systems.

ELECTRICAL (16)

Steady-State Analysis of Aircraft D-C Generators. Ernest Van Valkenburg and Whitney Matthews. *Electrical Engineering*, Vol. 67, No. 11, November, 1948, p. 1041, fig. (Summary of a paper.)

A mathematical analysis of the steady-state characteristics of a d.-c. generator that is equally applicable to compound and compensated machines. A practical degree of accuracy is obtained by using an empirical hyperbolic tangent function to express the dynamo's nonlinear electrical characteristics.

Auxiliary-Power Turbine Readied. *Aviation Week*, Vol. 49, No. 19, November 8, 1948, pp. 26, 27, illus. The Solar Aircraft Company Model 80 gas turbine has been developed to supply 400-cycle 120/208 volts a.c. for large aircraft. It is designed to operate at a normal maximum power rating of 50 kw.

Carbon-Pile Voltage Regulator Improvements. B. O. Austin and H. H. C. Richards. *Electrical Engineering*, Vol. 67, No. 11, November, 1948, 1083, illus. (Summary of a paper: Aircraft Carbon-Pile Voltage Regulator, Fundamentals and Design Improvements.)

Protection of the Airplane Main Bus. D. W. Exner. *Electrical Engineering*, Vol. 67, No. 11, November, 1948, p. 1050. (Summary of a paper.)

A Polarized Relay as an Aircraft Control Element. Royce E. Johnson and Frank A. Glassow. *Electrical Engineering*, Vol. 67, No. 11, November, 1948, p. 1059, diagr. (Summary of a paper.)

Aircraft Batteries (Lead and Alkaline); The Accumulatoren Fabrik A. G. Hagen, Hannover Plants. U.S. Naval Technical Mission in Europe. *Gt. Brit., British Intelligence Objectives Sub-Committee, Miscellaneous Report No. 46*, August, 1945. 52 pp., illus. British Information Services, New York. $1.90.

HYDRAULIC & PNEUMATIC (20)

An Essential Service. *The Aeroplane*, Vol. 75, No. 1951, October 29, 1948, pp. 562–566, illus., diagrs., cutaway drawings.

Description of the live-line pump and hand pump, electro-hydraulic control valves, liquid-spring shock absorber, and nose-wheel steering system developed by Dowty Equipment, Ltd., as components for aircraft hydraulic systems controlling, actuating, and operating or retracting flaps, nose wheel, and main undercarriage units.

Flight Testing (13)

Principles of Flight Testing. IV—Take-Off and Landing Factors. *Aircraft*, Vol. 27, No. 1, October, 1948, pp. 21, 42, 43, figs.

That Mysterious "Five-Engined Plane." *Aero Digest*, Vol. 57, No. 5, November, 1948, p. 21, illus. A B-17 Flying Fortress serving as a flying test bed for the Wright T-35 Typhoon turboprop installed in its nose.

Faster Than Sound; The D. H. 108 Flies in the Critical Transonic Speed Zone. *de Havilland Gazette*, No. 47, October, 1948, p. 3, illus.

Fuels & Lubricants (12)

The Oxidation, Ignition, and Detonation of Fuel Vapors and Gases. VI—The Prevention of Pre-Ignition and Detonation in Gas Engines. R. O. King, W. A. Wallace, and B. Mahapatra. *Canadian Journal of Research, Section F, Technology*, Vol. 26, No. 9, September, 1948, pp. 366–373, diagr., figs. 9 references.

Town gas containing hydrogen in large concentration can be used as fuel for a carburetor-type Otto-cycle engine at compression ratios as high as 10:1 and with mixtures of air in any proportion if the accumulation of fluffy carbon in the combustion space is prevented. This result confirms the nuclear theory of ignition which has been advanced to explain the cause of detonation in engines. Performance data are given for the variation of power and economy with mixture strength and ignition timing at compression ratios of 6, 8, and 10:1.

Purification, Purity, and Freezing Points of 30 Hydrocarbons of the API-Standard and API-NBS Series. Anton J. Strieff, Janice C. Zimmerman, and others. *U.S., National Bureau of Standards, Journal of Research*, Vol. 41, No. 4, October, 1948, pp. 323–357, diagrs., figs. 9 references. Available also as Research Paper No. RP1929. U.S. Govt. Printing Office, Washington. $0.20. Purification and determination of freezing points and purity of 30 hydrocarbons of the API-Standard and API-NBS series, including eight paraffins, six cycloparaffins, three aromatics, twelve olefins, and one actylene.

Hydrogen Peroxide: Production by Electrolysis of 35 Per Cent. Solutions; Deutsche Gold und Silber Anstalt. B. E. A. Vigers and W. S. Wood. *Gt. Brit., British Intelligence Objectives Sub-Committee, Final Report No. 683, Item No.* 22. 26 pp., illus British Information Services, New York. $0.90.

Gliders & Gliding (35)

Gliding and the Royal Air Force; Its Value as Flying Training. H. Neubroch. *Flight*, Vol. 54, No. 2082, November 18, 1948, pp. 589–591, illus.

Soaring in France: The Montagne Noire National Soaring Centre. Guy Borgé. *Sailplane and Glider*, Vol. 16, No. 10, October, 1948, pp. 3–6, illus.

Gliding Progress in New Zealand. *Sailplane and Glider*, Vol. 16, No. 10, October, 1948, pp. 2, 3.

The Adour (Castel-Mauboussin CM 7); New French High-Efficiency Two-Seater Sailplane. *Flight*, Vol. 54, No. 2080, November 4, 1948, p. 549, illus., fig.

Guided Missiles (1)

Telemetering Guided-Missile Performance. James C. Coe. *Institute of Radio Engineers, Proceedings*, Vol. 36, No. 11, November, 1948, *Waves and Electrons Section*, pp. 1404–1414, illus., diagrs., figs. 1 reference.

A discussion of the requirements of telemetering systems and their air-borne and ground installation, with details of antenna and transmitter installations, transducer designs, and frequency-modulated multiple-subcarrier and pulse-position systems used at the U.S. Naval Aircraft Missiles Test Center, Point Mugu, Calif. Includes a tabulation of the accuracies that can be obtained from frequency-modulated multiple-subcarrier telemetry, using variable-reactance transducers, to in-

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troduce the measured quantity into the transmitter; and a tabulation of the overall accuracy to be obtained when resistance transducers are attached to typical end instruments.

Industrial Relations (37)

Physical Capacity of Employees. F. E. Poole. *Aircraft Production*, Vol. 10, No. 121, November, 1948, pp. 388–380.

The employee-placement policy of the Lockheed Aircraft Corporation, in order to make the most efficient use of the abilities of its personnel, explicitly provides for physical limitations. After a comprehensive preplacement medical examination, the limited employee is assigned a class number that indicates to his immediate supervisor the types of activity the worker is prohibited from doing.

Instruments (9)

Blind-Flying Instrument with Coordinate System. Ulrich K. Henschke and Hans A. Mauch. *U.S., Air Force, Air Materiel Command, Engineering Division, Aero Medical Laboratory, Memorandum Report No. MCREXD-696-110 C (GS-USAF-Wright-Patterson #162)*, July 12, 1948. 11 pp., figs.

Development of the display of the "Reflex Horizon." The original model that was suspended in front of the pilot was modified for installation in an instrument panel. The indicating sphere is stabilized in space, and a portion of its illuminated coordinate system is projected on a ground glass by a lens system.

Adjustments Common to Mechanical Instruments. C. Williams. *The Technical Instructor*, Vol. 3, No. 10, October, 1948, pp. 12–16, figs. Lever-length and lever-angle adjustment of the altimeter, air-speed indictor, and the rate-of-climb indicator.

On the Level; A New Electrically-Actuated Gyro Horizon by Sperry. *Flight*, Vol. 54, No. 2078, October 21, 1948, pp. 479, 480, illus.

Pointing the Limit; A New Smiths Instrument to Show Actual and Maximum Safe Air Speed. *Flight*, Vol. 54, No. 2080, November, 1948, pp. 550, 551, illus., cutaway drawings.

Know Your Compass. Robert F. Sanderson. *Skyways*, Vol. 7, No. 11, December, 1948, pp. 32, 33, 47, 48, 51, illus. Directions for using a compass rose or an astrocompass to determine the deviation of an airplane magnetic compass.

Characteristics of a Magnetic Compass. I. A. Kingsnorth. *The Technical Instructor*, Vol. 3, No. 10, October, 1948, pp. 3–9, figs.

Beryllium Nickel Alloys. *U.S., Field Information Agency, Technical, Technical Bulletin No. T-25*, April 21, 1947. 2 pp. British Information Services, New York. $0.10. Manufacture and properties of titanium and beryllium bearing alloys manufactured by Heraeus-Vacuum Schmelze, Hanau, for use in watch springs.

Laboratories, Aeronautical (50)

Wartime Aeronautical Research & Development in Germany. I. J. J. Green, R. D. Hiscocks, and J. L. Orr. *Engineering Journal*, Vol. 31, No. 10, October, 1948, pp. 531–533, illus.

The general organization, control, direction, and policy of German aeronautical research establishments and their relation to industry, government, and the armed forces. Descriptions of the plant, equipment, facilities, personnel, and research programs of the Luftfahrtforschungsanstalt Hermann Göring, the Luftforschungsinstitut Graf Zeppelin, the Luftfahrtforschungsanstalt München, and the high-speed wind tunnel of the Deutsche Versuchsanstalt für Luftfahrt are condensed from a report submitted by an inspection team of the National Research Council, Canada.

Deutsche Forschungsanstalt für Segelflug (German Glider Research Station). John A. O'Mara. *Combined Intelligence Objectives Sub-Committee, Item No. 6, File No. 32-66.* 221 pp., illus. British Information Services, New York. $4.80.

Translations of reports made to the C.I.O.S. team by Dr. W. J. O. Georgii, the director of the Deutsche Forschungsanstalt für Segelflug, and by the heads of its various subdivisions give an overall picture of the way aeronautical research was organized in Germany and a résumé of the work of this establishment in pure research and in the design, development, and testing of aircraft and aircraft equipment. Projects undertaken between 1939 and 1945 included; methods of towing gliders; troposphere gliding; air-intake diffuser design for intermittent-jet engines; aircraft stability; automatic control systems; infrared television; and gyroscope theory. In addition to a brief history and outline of the organization of the establishment and a list of its personnel, a summary is given of the theoretical mathematical work done in Germany on the problem of pursuit curves. This summary is accompanied by two detailed papers on the same subject—one by Dr. Hellmuth Hasse and the other by Dr. W. Magnus. An index with brief abstracts or annotations is included of the publications of the D.F.S. which were received by the Allied Documents Receiving Center.

A Hightly Sensitive Differential Manometer. *U.S., National Bureau of Standards, Technical Report No. 1292*, November, 1948. 3 pp. 1 reference.

Pressure differences as small as one millionth of an atmosphere can be detected over a range of total pressure from 1 mm. to 1 atmosphere. It operates on the principle of the aneroid barometer and may be used to compare pressures of gases, organic vapors, and noncorrosive liquids.

The Zehnder-Mach Interferometer. T. J. Keating. *Plane Facts*, Vol. 5, No. 10, October, 1948, pp. 20, 21, 28, 29, figs. The principle of the Zehnder-Mach interferometer and its application to the quantitative variation in density or temperature of an air stream.

Continuous Oscillograph Camera for Ionosphere Measurements. James E. Hacke, Jr. *Instruments*, Vol. 21, No. 10, October, 1948, pp. 914, 915, illus.

Navy Using Largest Test Machine. *Aviation Week*, Vol. 49, No. 19, November 8, 1948, p. 33, illus., diagr.

Description, method of operation, and regulation of the 2,500-ton-capacity Baldwin testing unit. Thirty-foot specimens can be subjected to compression and tension. Fifty-foot specimens can be accommodated in bending tests.

Machine Elements (14)

"Necked" or "Waisted" Screws and Bolts; Their Possibilities in the Field of Engine Production. P. M. Heldt. *Automotive Industries*, Vol. 99, No. 9, November 1, 1948, pp. 42, 43, 82, 84, figs.

Journal Bearings with Diminishing Oil Supply. H. A. S. Howarth. *Product Engineerng*, Vol. 14, No. 11, November, 1948, pp. 104–109, figs.

Nut and Bolt Considerations. *Plane Facts*, Vol. 5, No. 10, October, 1948, pp. 14, 15, illus. Description of the data that can be obtained with the torsion and tension machine and the vibration machine developed by the Delron Company, Inc. for testing nuts and bolts under service conditions.

Maintenance (25)

Phase Maintenance. S. N. Rosengren. *Aviation Maintenance & Operations*, Vol. 10, No. 6, November, 1948, pp. 26, 27, tables. The phase-maintenance program adopted by Scandinavian Airlines System. Greater aircraft utilization increased revenues by 25 per cent.

Checking Engine Clearances. *Aviation Maintenance & Operations*, Vol. 10, No. 6, November, 1948, pp. 24, 25, illus. Includes tabulation of recommended clearances for Continental engines.

To Paint or Not To. Lee Irwin. *Skyways*, Vol. 7, No. 12, December, 1948, pp. 20–22, 42, 49, illus. Comparison of cost of maintaining an aircraft with a wax-polished skin with that of an aircraft with a painted skin.

Douglas Service, Vol. 6, No. 11, November, 1948. 20 pp. illus., diagrs., figs.

Contents: Propellers—Description and Operation of Hamilton Standard Hydromatic Propellers, DC-6. Service Hints, General. Flight Controls Rigging Chart—Throw and Tolerances, DC-6. Propeller Synchronizer—Description, Function and Rigging of System, DC-6. Cabin Pressure Valves—Rigging Procedure for Manual and Automatic Relief Valves, DC-6. Cabin Supercharger Lubricants—Approved Oils and Greases, DC-6. Cabin Humidifier System—Operation and Maintenance, DC-6. Service Bulletins, DC-4, DC-6. Cabin Supercharger Tool, DC-6. CO_2 Discharge Nozzles, DC-6. Ventilating Duct Drains—Description of System, DC-6. Advance Engineering Changes,

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Materials (8)

METALS & ALLOYS

Fracturing Characteristics of Aluminum-Alloy Plate. E. Klingler and G. Sachs. *Journal of the Aeronautical Sciences*, Vol. 8, No. 12, December, 1948, pp. 731–734, figs. 8 references.

Commercial hot-rolled $1^1/_2$-in. 24ST aluminum plate exhibited large variations in fracture stress and reduction in area for different orientations of the test specimens. These variations were attributed to mechanical anisotropy in the plate. Measurement of the angles at which the specimens fractured indicated the presence of a plane of weakness, but no fracture function could be found to correlate this with the fracture stresses and ductilities.

Ultimate Stresses Developed by 24S-T and Alclad 75S-T Aluminum-Alloy Sheet in Incomplete Diagonal Tension. L. Ros Levin. *U.S., N.A.C.A., Technical Note No. 1756*, November, 1948. 13 pp., figs. 5 references.

The ultimate shear stress indicated by tests was essentially independent of the rivet factor if the rivet factor was greater than 0.6. Curves showing the effect of diagonal tension on the ultimate shear stress in the gross section supersede those given in *N.A.C.A. Technical Note No. 1364*.

A Metallurgical Investigation of Two Turbosupercharger Discs of 19-9DL Alloy. E. E. Reynolds, J. W. Freeman, and A. E. White. *U.S., N.A.C.A., Technical Note No. 1535*, November, 1948. 25 pp., figs. 4 references.

Two turbosupercharger discs of 19-9DL alloy were tested to determine the properties at room temperature and 1,200°F. of this material in forgings of the size used in service. Both discs were given hot-cold-working treatments at 1,300° to 1,350° F., but one was solution-treated and the other left in the as-forged condition. Because the number of specimens was limited General Electric Company data are included. Rupture strengths at 1,200°F. were good. Benefits of hot-cold-work on rupture strengths at 1,200°F. were not retained at 1,350°F.; rupture test ductility was extremely low; the discs had fair uniformity of properties; and the properties compared favorably with those of bar stock. There was no appreciable difference in properties between the two forgings.

Symposium on the Welding of Light Alloys: Discussion of Technical Paper on The Causes of Scatter in the Tensile Strength of Magnesium-Manganese Alloy Welds. *Sheet Metal Industries*, Vol. 25, No. 259, November, 1948, pp. 2274, 2276.

Properties of 19-19DL Alloy Bar Stock at 1200° F. J. W. Freeman, E. E. Reynolds, D. N. Frey, and A. E. White, *U.S., N.A.C.A., Technical Note No. 1758*, November, 1948. 41 pp., figs. 2 references.

Data were obtained 1,200°F. for 19-9DL alloy bar stock in three conditions: hot-rolled, hot-cold-rolled, and solution-treated. All samples were stress-relieved. Properties reported include tensile data at room temperature and tensile, rupture, creep, total-deformation, and stability test data at 1,200°F. Hot-cold-worked stock gave highest strengths at 1,200°F. for short time periods and high stresses. Solution treatment was best for long time periods and low stresses. Properties showed that strength is dependent on the composition, size, dispersion and precipitated particles, strain-hardening from cold-work, and structural stability.

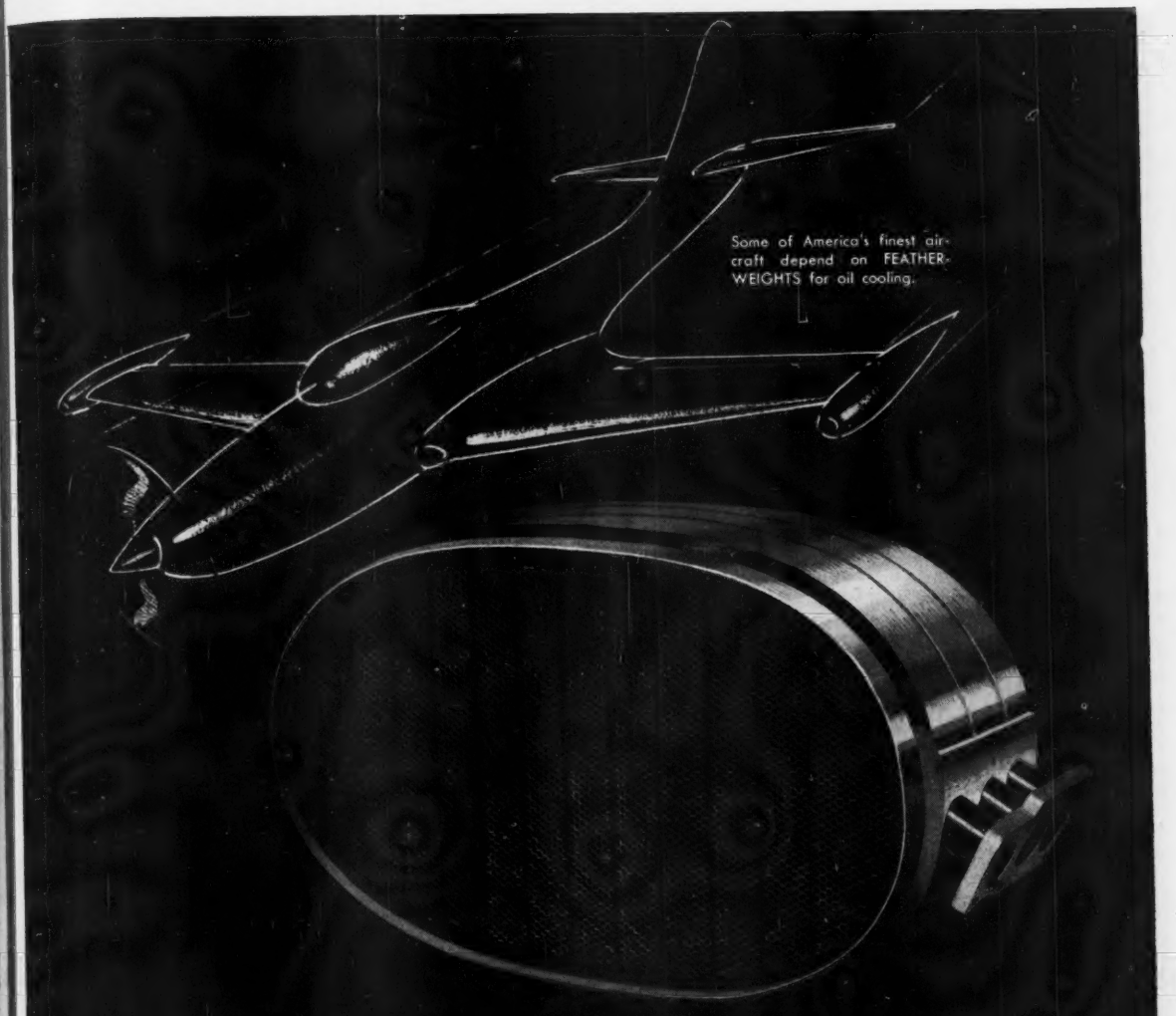
Metal Cleaning. T. C. Du Mond. *Materials & Methods*, Vol. 28, No. 5, November, 1948, pp. 83–94, illus.

The Production of Aluminum in Italy. W. B. C. Perrycoste. *Gt. Brit., British Intelligence Objectives Sub-Committee, Final Report No. 308, Item No. 21*, February, 1946. 30 pp. British Information Services, New York. $1.00.

Finishes for Machine Parts. Joseph Mazia. *Machine Design*, Vol. 20, No. 10, October, 1948, pp. 125–128, illus.

Materials Joined by New Gold Welding Process. A. B. Sowter. *Materials & Methods*, Vol. 28, No. 5, November, 1948, pp. 60–63, illus.

Light Alloys in Western Germany, with Particular Reference to Rolling of Magnesium Alloys, and Rolling Mills. A. Brandt, J. L. Haughton, R. Jones, and others. *Gt. Brit., British Intelligence Objectives Sub-Committee, Final Report No. 1756, Item No. 21*. 66 pp., diagrs. British Information Services, New York. $1.90.



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Magnetic Measurement of Composite Copper-Nickel Coatings. *U.S., National Bureau of Standards, Technical Report No. 1289,* November, 1948. 4 pp., fig. 1 reference.

A nondestructive magnetic method for determining the thickness of composite copper-nickel coatings electrodeposited on steel. By measuring the attractive force between the plated specimen and two permanent magnets of different strengths, values are obtained which, in conjunction with a set of previously determined calibration curves for each magnet, indicate the total thickness of the coating and the relative thickness of the copper and nickel layers.

Low-Temperature Properties of 18:8 Steel. *U.S., National Bureau of Standards, Technical News Bulletin,* Vol. 32, No. 11, November, 1948, pp. 129–132, illus., figs.

Some European Researches On Passivity. U. R. Evans. *Corrosion,* Vol. 4, No. 11, November, 1948, pp. 545–556. 27 references.

NONMETALLIC MATERIALS

High-Temperature Ceramic Coatings for Molybdenum. *U.S., National Bureau of Standards, Technical News Bulletin,* Vol. 32, No. 11, November, 1948, pp. 125, 126, figs.

German Laminated Plastic and Sleeving Industry. F. G. Cooke and P. J. Gordon. *Gt. Brit., British Intelligence Objectives Sub-Committee, Final Report No. 1709, Item No. 22.* 10 pp. British Information Services, New York. $0.55. Methods used in the production of resin-impregnated cotton sleeving, coated wire, and boards made of compressed resin-impregnated paper which were used for aircraft fuselage construction.

Electrical Aspects of Buna, with Some Notes on Other Dielectrics. I, II. G. M. Hamilton and A. A. New. *Gt. Brit., British Intelligence Objectives Sub-Committee, Final Report No. 1714, Item No. 22,* 1944. 2 Vols., 323, 387 pp., illus., diagrs., figs. 130 references. British Information Services, New York. $7.15, $10.80.

A summary of I. G. Farben research on the electrical and mechanical properties of Buna synthetic rubbers, polyvinylchloride, phenolic resins, polyurethanes, polystyrene, polyisobutylene (Oppanol), polyethylene (Lupolen), and acetylated and resin impregnated cable paper. Mechanical, electrical, thermal, optical, and chemical methods were used in the testing of polymers. The degree of polymerization was determined from the molecular weight obtained by an osmometric method, and the degree of branching was established from viscosity determinations. Considerable improvement in the electrical properties of polymers, which persisted in the vulcanisate, was achieved by special methods of precipitation of emulsion-polymerised lattices and by washing the product. The resistivity and dissipation factor could be improved to some extent by an increase in the styrene content, but this had the undesirable effect of increasing the temperature coefficient and of decreasing the cold resistance of the product. The best values were displayed by the bulk-polymerized numbered Bunas. Research had been done on the development of blowing agents for manufacturing sponge rubber, accelerators, softeners, and fillers and extenders and also on the structural origin of the electrical and mechanical properties of Bunas. The nomenclature of the numbered and lettered Bunas is included. The report, in general, is based on interrogations of I. G. Farben personnel, with sufficient interpolation of related matter from I. G. Farben reports and publications, to which reference was made to correlate the wide field covered. The appendixes contain the texts of two English publications and translations of 39 of the more important reports of I. G. Farben workers in this field.

SANDWICH MATERIALS

Bending and Buckling of Sandwich Beams. N. J. Hoff and S. E. Mautner. *Journal of the Aeronautical Sciences,* Vol. 8, No. 12, December, 1948, pp. 707–720, illus., figs. 5 references.

A theory, based on the principle of virtual displacements, is developed for the bending and buckling of structural elements of sandwich construction. Comparatively simple formulas, suitable for routine calculations, are obtained by considering only the essential portions of the strain energy stored during deformation. These are the strain energy caused in the faces by extension and bending and that caused in the core by shear and by extension perpendicular to the plane of the faces. The strain energy of shear in the faces and that of extension parallel to the faces in the core are disregarded. Beam and column test results from 64 specimens were in good agreement with theory in all the beam tests and in the column tests when the core of the sandwich structure was balsawood. A number of sandwich columns having a cellular cellulose acetate core failed under loads smaller than those predicted by theory. This early buckling was attributed to weak spots in the core material or the adhesive.

Meteorology (30)

Meteorological Conditions Favourable for the Occurrence of Poor Visibility and of Low Cloud at Shannon Airport. M. G. Granville. *Ireland, Meteorological Service, Technical Note No. 9 (Advance Issue),* 1948. 4 pp.

Winter Precipitation as Related to the 700-Mb Circulation. William H. Klein. *American Meteorological Society, Bulletin,* Vol. 29, No. 9, November, 1948, pp. 439–453, figs. 24 references.

Humidity Test Apparatus. *U.S., National Bureau of Standards, Technical News Bulletin,* Vol. 32, No. 11, November, 1948, pp. 127, 128, illus., diagr. 1 reference.

The divided-flow, low-temperature humidity test apparatus produces air of known relative humidity at temperature from 0° to −40°C. for calibrating and testing the humidity-sensing elements used in radiosonde equipment.

Military Aviation (24)

Operational Concepts for Modern War. Dale O. Smith. *Air University Quarterly Review,* Vol. 2, No. 2, Fall, 1948, pp. 3–14. An evaluation of the combat effectiveness of the atomic bomb and a comparison of the operational doctrine required for its efficient employment with conventional sustained bombing operations.

Air Power and Principles of War. Frederick E. Calhoun. *Air University Quarterly Review,* Vol. 2, No. 2, Fall, 1948, pp. 37–47.

The Strategic Striking Force. Frank R. Pancake. *Air University Quarterly Review,* Vol. 2, No. 2; Fall, 1948, pp. 48–56. An analysis of the essential requirements for the conduct of successful strategic air operations.

Air Power and Foreign Policy. John P. Healy. *Air University Quarterly Review,* Vol. 2, No. 2, Fall, 1948, pp. 15–26.

Radio Counter-Measures; (Their Role in Aerial Warfare). Frederick L. Moore. *Air University Quarterly Review,* Vol. 2, No. 2, Fall, 1948, pp. 57–66.

Plane-Sub Team Devised for Navy. Robert Hotz. *Aviation Week,* Vol. 49, No. 19, November 8, 1948, pp. 12, 13, illus. A proposal to use flying boats, fueled and supplied at sea by submarine tenders, for long-range bombing operations.

The Berlin Airlift. Paul Fisher. *The Bee-Hive,* Vol. 23, No. 4, Fall, 1948, pp. 3–31, illus.

"Can Do!" Gill Robb Wilson. *The Pegasus,* November, 1948, pp. 1–5, illus. The Berlin air lift.

Antarctic and Aviation. Frank Illingworth. *Flight,* Vol. 54, No. 2080, November 4, 1948, pp. 541, 542, illus.

Operations

COMMERCIAL (41)

Scheduled Airlines' Progress Toward Regularity of Service and On-Time Operation. Milton W. Arnold. *Air Transport Assn. of America,* November 10, 1948. 14 pp. (An address.)

The installation of I.L.S., the distribution of arrival and departure load peak, and more efficient airport and ground handling procedures at La Guardia Airport have substantially reduced the number of flight cancellations, flight delays, and the duration of the delays during the first quarter of 1948.

The Elephant and the Mouse. *The Aeroplane,* Vol. 75, No. 1952, November 5, 1948, pp. 594–596. A discussion of the traffic potential for second-class air-transport accommodations

Freighting Lore: Air Mail. I. H. W. Ainsley. *Airports & Air Transportation,* Vol. 3, No. 65, November, 1948, pp. 119–122, illus. A brief history of British air-mail policy.

A Visit to America; Some Facts, Figures and Impressions of the Aviation Scene in USA and Canada. Stanley Brogden. *Aircraft,* Vol. 27, No. 1, October, 1948, pp. 12–15, 36, 38, illus.

Anglo-American Civil Air Relations; A Review by the U.S. Civil Air Attaché of Developments in Civil Aviation During the Immediate Post-War Period. L. Satterthwaite. *Flight*, Vol. 54, No. 2079, October 28, 1948, p. 510.

Cargo-Wise K. L. M. Joseph M. Chase. *Aviation Maintenance & Operations*, Vol. 10, No. 6, November, 1948, pp. 21–23, 56, 60, illus. Techniques used by the Royal Dutch air lines to reduce cargo delivery time.

Some Economic Factors in Civil Aviation. III. Peter Masefield. *Flight*, Vol. 54, No. 2078, October 21, 1948, pp. 496–498, figs. (Extended summary of a paper.)

Why the Original Air Cargo, Inc., Agreement Stands; The Official Opinion of the Civil Aeronautics Board. *Air Transportation*, Vol. 13, No. 4, October, 1948, pp. 88, 96–98.

Air Shippers' Manual. *Air Transportation*, Vol. 13, No. 4, October, 1948, pp. 27–82. Lists of cargo agents, air-freight forwarders, U.S. and foreign air lines; routes; mail, parcel-post and cargo rates; regulations; and air-line distances.

Air Transport in the Sudan. *The Aeroplane*, Vol. 75, No 1951, October 29, 1948, pp. 567–569, illus.

Norway's Artic Air Route. *The Aeroplane*, Vol. 75, No. 1950, October 22, 1948, pp. 535–539, illus.

Aviation in the Southwest Pacific. Leo White. *Whites Aviation*, Vol. 4, No. 44, October, 1, 1948, pp. 3, 5, 6, 9, 11, 13, 14, 17, 19, 21, illus.

Purchasing for Profit. Edwin Laird Cady. *Aviation Maintenance & Operations*, Vol. 10, No. 6, November, 1948, pp. 36, 37, 49, 50, 52, 55, illus. The service rendered by the aviation distributor in supplying parts and accessories to operators.

Photography (26)

Aerial Photographic Equipment and Applications to Reconnaissance. Amrom H. Katz. *U.S., Air Force, Air Technical Intelligence, Technical Data Digest*, Vol. 13, No. 21, November 1, 1948, pp. 13–21, illus. 4 references.

A review of the equipment of present used or being developed for air photoreconnaissance. A stabilized camera mount and moving film to compensate for the forward motion of the airplane have made possible the photography of objects moving at a relative speed of 1,000 m.p.h. High-altitude photographs have required the development of cameras and lenses with focal lengths as long as 100 in. The limited resolution that can be obtained in enlargements necessitated the development of cameras and lenses with focal lengths as great as 100 in. Lens systems have been developed that automatically compensate for high-altitude temperature and pressure effects on the focus of the camera.

Rocket Cameras Record Earth's Surface from 57 Miles Up. *Flight*, Vol. 54, No. 2079, October 28, 1948, pp. 516, 517, illus.

Power Plants

JET & TURBINE (5)

Theoretical Evaluation of the Ducted-Fan Turbojet Engine. Richard B. Parisen, John C. Armstrong, and Sidney C. Huntley. *U.S., N.A.C.A., Technical Note No. 1745*, November, 1948. 29 pp., figs. 5 references.

The ducted-fan turbojet engine is compared with turbojet and turbine-propeller engines for maximum thrust, minimum fuel consumption, and maximum range at flight Mach Numbers from 0.3 to 0.9 at an altitude of 30,000 ft. Maximum range comparison includes pay-load-to-gross-weight ratios from 0.0 to 0.4. For flight Mach Numbers up to approximately 0.6, the turbine-propeller engine offers most favorable performance of any of the engines considered. For higher flight Mach Numbers, the turbojet engine with tailpipe burner (operating for thrust augmentation and non-operative for range) offers maximum performance flexibility.

N.A.C.A. Investigation of Gas-Turbine-Blade Cooling. Herman H. Ellerbrock, Jr. *Journal of the Aeronautical Sciences*, Vol. 8, No. 12, December, 1948, pp. 721–730, figs. 7 references.

A review of the analytical and experimental work done by the N.A.C.A. on the cooling of turbine blades. The theoretical studies show that by increasing the gas temperature at the turbine inlet, gas-turbine engine performance can be improved sufficiently to compensate for the losses that are introduced by any cooling system that may be used to keep the turbine blades in a temperature range where they retain adequate strength. Although, with present-day metals, rim cooling allows little increase in effective gas temperature, it appreciably increases the blade life. At a Mach Number of 0.6, an effective gas-temperature increase of about 500°F. can be obtained with hollow-blade air cooling. This can be raised to about 650°F., if an insert is placed in the hollow. Liquid-cooled high-melting-point alloy-steel turbines should be able to operate at turbine-inlet temperatures near the maximum obtainable with present-day fuels. Experimental data obtained with static- and rotating-cascade test rigs have supplemented and substantiated the theoretical analyses and, in conjunction with the theory of turbine-blade cooling, are expected to lead to methods for the rigorous design of cooled turbines.

Master Turbine-Impellers. *Aircraft Production*, Vol. 10, No. 121, November, 1948, pp. 363, 364, illus. Measuring rig used by the de Havilland Engine Company, Ltd., in the shaping and inspection of master gas-turbine impellers with an accuracy of 0.0025 in., for use with a special-purpose Cincinnati profiling machine.

Design of Turbojet Installations. II. D. J. Jordan. *Aero Digest*, Vol. 57, No. 5, November, 1948, pp. 74, 76, 81, 82, 108, diagrs.

A comparison of jet-engine and reciprocating-engine power-control, ignition, starting, and cooling systems. Includes description of the barometric and the all-speed governor fuel-supply control; the variable-area nozzle control; internal and external cooling systems; tailpipe insulation blankets; engine-mount design; and lubrication systems.

Description of Allison Engine Powered Test Facility at Cornell Aeronautical Laboratory. W. McDole and W. Lenz. *Cornell Aeronautical Laboratory, Inc., Report No. 511,107-1*, October 1, 1948. 31 pp., illus., diagrs., figs. 4 references.

The design and installation of an air-supply system powered by a modified Allison V-1710 aircraft engine driving the two-stage mechanical supercharger unit from an Allison V-3420 for testing thermojet units and components. The unit is capable of producing a free jet of supersonic velocity, and the pressure ratio and mass flows measured are adequate for the induction drive of a supersonic wind tunnel.

German Practices in Drawing and Forging Turbine Blades. R. T. Wilson. *Steel Processing*, Vol. 34, No. 10, October, 1948, pp. 545–548, diagrs., figs. Compiled from: *U.S., Field Information Agency, Technical, Final Reports Nos. 1129, 1148.*

F-80 (Lockheed) Flies on Ramjet Power Alone. *Aviation Week*, Vol. 49, No. 19, November 8, 1948, p. 14, illus.

Jet Engine Packaging (by Edo Corporation). *Aero Digest*, Vol. 57, No. 5, November, 1948, p. 61, illus.

Power Plants for British Giants (Bristol Proteus Turbo-Prop Engines). *Aircraft*, Vol. 27, No. 1, October, 1948, p. 18, illus.

The Most Severe Aero Engine Test in History. *de Havilland Gazette*, No. 47, October, 1948, pp. 8, 9, illus., figs. Test-bed-performance of a Goblin 2 jet engine during 462 test cycles, each of 65 min. duration.

The (General Electric) TG-100B Turbine-Propeller Engine; A Design Analysis. Howard E. Grantz. *Aero Digest*, Vol. 57, No. 5, November, 1948, pp. 37–40, 116–119, illus., diagrs.

Two Novel U. S. Projects. *The Aeroplane*, Vol. 75, No. 1950, October 22, 1948, p. 534, illus., diagr. The Marquardt ram-jet power plant and the M-14 pulse-jet helicopter.

SOCEMA Aircraft Turbines; The Record of a French Development Programme. *Flight*, Vol. 54, No. 2082, November 18, 1948, pp. 608–610, illus., diagrs.

Two Swedish Turbojets (SFA Two-Stage Centrifugal and STAL Axial-Flow Straight-Through). *Flight*, Vol. 54, No. 2082, November 18, 1948, p. 594, illus.

RECIPROCATING (6)

Cirrus Bombardier (Blackburn). *Flight*, Vol. 54, No. 2078, October 21, 1948, pp. 487–491, illus., cutaway drawings.

A New Light Aero Engine (Blackburn Cirrus Bombardier 702). *The Aeroplane*, Vol. 75, No. 1950, October 22, 1948, pp. 530–533, illus., cutaway drawing.

Engine Conditioning (at Air Materiel Command). I—The Need for Engine Conditioning. *Aviation Maintenance & Operations*, Vol. 10, No. 6, November, 1948, p. 30.

Metallurgical Examination of Japanese Sakae-12, Engine No. 124676. L. H. Grenell, J. R. Cady, and H. W. Gillett. *Gt. Brit., British Intelligence Objectives Sub-Committee, Report No. B.I.O.S./J.A.P./P.R. 1466*, February 12, 1945. 44 pp., figs. British Information Services, New York. $1.90.

Production (36)

Further Investigations on the Pressure Welding of Light Alloy Sheet. R. F. Tylecote. *Institute of Welding, Transactions*, Vol. 11, No. 5, October, 1948, pp. 94r–108r, diagrs., figs. 13 references.

Substantial improvement can be obtained by solution heat-treatment of welds made in clad duralumin alloys with small reductions in sheet thickness. This is caused by the diffusion of the core constituents, which strengthens the low-strength cladding. High-purity aluminum has been successfully welded between rollers at room temperature. The electrical projection welding machine supplies heat and pressure automatically and has made practical the industrial application of pressure welding to aluminum of commercial purity and aluminum-manganese alloy.

Gas Welds in a High Strength Aluminum-Zinc-Magnesium-Copper Alloy. J. Pendleton. *Institute of Welding, Transactions*, Vol. 11, No. 5, October, 1948, pp. 87r to 93r, figs. 17 references.

A general investigation of the welding of a typical high-strength aluminum-zinc-magnesium-copper alloy by the oxy-acetylene process shows that there is a pronounced tendency to cracking if the welds are made under constraint. The metal adjacent to the weld becomes porous, and superficial blistering may occur on the underside of the sheets. Comparatively low welding efficiencies, of the order of 70 per cent, are obtained unless complete heat-treatment of the welded structure is performed.

Production Costs; Some Factors Affecting Cost–Weight Ratios in Civil Aircraft. Peter G. Masefield. *Aircraft Production*, Vol. 10, No. 121, November, 1948, pp. 375–377, fig. (Extended summary of a paper.)

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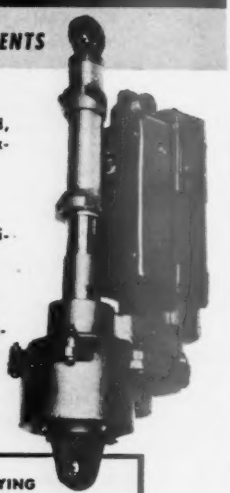

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Alignment Testing. II—Some Practical Applications of the Telescope, Auto-Collimator and Block Level. K. J. Hume. *Aircraft Production*, Vol. 10, No. 121, November, 1948, pp. 391–393, figs.

In Production. I. Fred P. Laudan. *Boeing Magazine*, Vol. 18, No. 10, October, 1948, pp. 3–5, 14, illus. Preproduction planning of an airplane.

Canada's Jet Airliner (Avro C.102) in Jigs. *Automotive Industries*, Vol. 99, No. 10, November 15, 1948, pp. 44, 45, illus.

The Canadair Four (Avro Transport); Made in Canada. *Aircraft & Airport*, Vol. 10, No. 10, October, 1948, pp. 12–14, 16, 18, 20, 22, 23, 26, 27, illus., diagr., cutaway drawing.

Machining (Fairey) Firefly Components; Operations on the Latchpin Attachment Fitting for the Rear Centre-Section Spar and Other "Difficult" Units. J. A. Oates. *Aircraft Production*, Vol. 10, No. 121, November, 1948, pp. 380–387, illus., diagr.

Hawker Sea Fury. II—Front Fuselage Assembly; Rear Fuselage; Tail-Bay with Integral Fin. S. C. Poulsen. *Aircraft Production*, Vol. 10, No. 121, November, 1948, pp. 366–374, illus., diagrs.

Propellers (11)

Investigation of the VDM Propeller Works, Frankfurt/Main and Hasselborn. John D. Waugh. *Combined Intelligence Objectives Sub-Committee, Item No. 5, 26, 27, File No. 31-8*, August 15, 1945. 29 pp., figs. British Information Services, New York. $1.00.

Description of the basic design of the V.D.M. (Vereinigte Deutsche Metallwerke) variable-pitch propeller, the electric automatic pitch-changing system developed by Messerschmitt, and the hydraulic automatic pitch-changing mechanism of Focke-Wulf. V.D.M. also developed the Me. P-8 propeller, which provided aerodynamic braking both in the air and on the ground. V.D.M. was working on the design of a propeller for turboprop engines.

Rotating Wing Aircraft (34)

How a Helicopter Is Tested for CAA Certification. *Aviation Week*, Vol. 49, No. 18, November 1, 1948, pp. 22–24, illus.

Cierva Skeeter Flies. *Flight*, Vol. 54, No. 2078, October 21, 1948, pp. 477, 478, illus.

Details of the Kaman K-190. Alexander Klemin. *Aero Digest*, Vol. 57, No. 5, November, 1948, pp. 51, 52, 120–122, illus.

World's Largest Helicopter (XH-16) by Piasecki. *Plane Facts*, Vol. 5, No. 10, October, 1948, pp. 24, 25, illus.

Sciences, General (33)

MATHEMATICS

The Relative Accuracy of Quadrature Formulae of the Cotes' Closed Type. S. Kirkby. *College of Aeronautics, Cranfield, England, Report No. 17*, May, 1948. 6 pp. 4 references.

It is shown that, for closed type formulas, the error due to application of a $2n$-strip formula is, in general, less than that due to a $(2n + 1)$-strip formula over the same range of integration when the same tabular interval of the argument is used.

Stress Analysis & Structures (7)

The Behavior of Thin Cylindrical Shells After Buckling Under Axial Compression. Herman F. Michielsen. *Journal of the Aeronautical Sciences*, Vol. 8, No. 12, December, 1948, pp. 738–744, figs. 3 references.

The fundamental investigations of von Kármán and Tsien on the buckling of cylindrical shells under axial compression are continued. The energy expression is simplified and minimized with respect to the axial and circumferential wave-length parameters. Solution of the equations that are obtained yields curves of the reduced average stress and of the wave dimensions plotted against the reduced average strain. They illustrate the behavior of the cylinder during the buckling process. The minimum buckling stress is found to be $0.195E(t/R)$.

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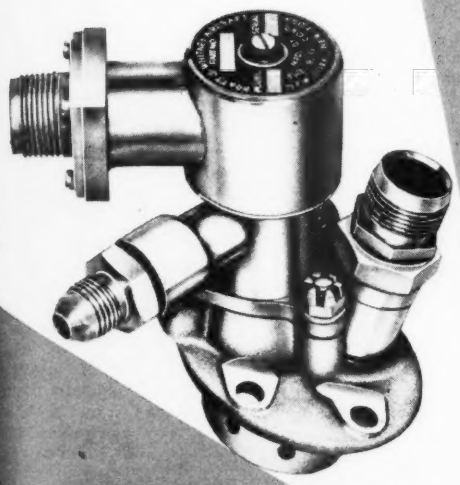

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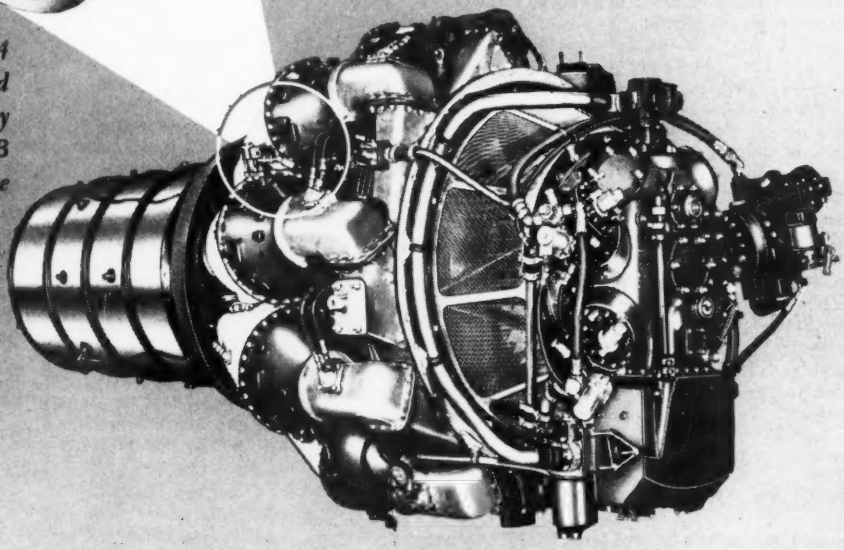

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Buckling Tests of Flat Rectangular Plates Under Combined Shear and Longitudinal Compression. Roger W. Peters. *U.S., N.A.C.A., Technical Note No. 1750,* November, 1948. 14 pp., illus., figs. 3 references.

An experimental investigation to determine the validity of a theoretical parabolic interaction curve for the elastic buckling of flat rectangular plates under combined shear and longitudinal compression loads. The four flat rectangular plates tested formed the sides of a square box with corner angles. Although some of the points that were determined experimentally lay above the others below the theoretical interaction curve, the curve plotted from the average of individual experimental points lies close to this theoretical curve. It has been recommended for design use.

Flutter of Systems with Many Freedoms. W. J. Duncan. *College of Aeronautics, Cranfield, England, Report No. 19,* August, 1948. 21 pp. 11 references.

In order to determine whether a particular degree of freedom must be included in the calculation of a critical flutter speed, its influence upon the energy balance should be examined when the freedom is expressed in the form of a Lagrangian dynamical equation. Brief outlines of methods for predicting flutter characteristics include: nondimensional form of the equations of motion; the orthodox method of solution; the method of R. A. Frazer; methods based on the use of matrices; the method of Duncan, Collar, and Lyon; and a modification of this latter inverse method.

Effect of Variation in Diameter and Pitch of Rivets on Compressive Strength of Panels with Z-Section Stiffeners; Panels That Fail by Local Buckling and Have Various Values of Width-To-Thickness Ratio for the Webs of the Stiffeners. Norris F. Dow and William A. Hickman. *U.S., N.A.C.A., Technical Note No. 1737,* November, 1948. 21 pp., figs. 5 references.

Panels were of such length that failure was by local buckling. Regardless of the width-to-thickness ratio, the compressive strengths of the panels were found to increase appreciably with either an increase in the diameter of the rivets or a decrease in the pitch of the rivets.

Determination of Coupled and Uncoupled Modes and Frequencies of Natural Vibration of Swept and Unswept Wings From Uniform Cantilever Modes. Roger A. Anderson and John C. Houbolt. *U.S., N.A.C.A., Technical Note No. 1747,* November, 1948. 42 pp., figs. 4 references.

An energy solution is given for the determination of the coupled or uncoupled modes and frequencies of swept or unswept airplane wings. Expansions for deflection and rotation are made in terms of uniform cantilever modes. The Crout method of solution is employed. Examples show that only a small-order determinant is needed to obtain accurate solutions.

Creep Measurement with Wire Gauges. *Electrical Engineering,* Vol. 67, No. 11, November, 1948, p. 1041.

Elongation-time curves, plotted with SR-4 bonded resistance-wire strain-gage data obtained by the Canadian Bureau of Mines in creep measurements at room temperature, yielded a smoother curve with less spread than the curves obtained with a mechanical extensometer.

Applying the Polariscope. Ray W. Clough. *Product Engineering,* Vol. 14, No. 11, November, 1948, pp. 124–128, diagrs., figs. Method and the interpretation of data in photoelastic analysis.

Thermodynamics (18)

Thermodynamic Properties of Air at High Temperatures. J. C. Hirschfelder and J. L. Mageo. *U.S., Atomic Energy Commission, Document,* January 10, 1947. 38 pp., tables. PB-63828, Publications Board Project, Photoduplication Service, Library of Congress, Washington. Microfilm, $1.00; photostat, $3.00.

A series of tables, extending those of Brinkley, Kirkwood, and Richardson by continuing their work through computation of the variation of the thermodynamic properties of the atmosphere for densities 0.0001 times the normal density of air. The value in these tables have been adjusted to fit smoothly onto those of Fuchs, Kynch, and Peierls in the extremely high-temperature range, over 25,000°K.; onto the values of H. Bethe in the temperature range between 25,000° and 15,000°K.; and onto the values of Brinkley, Kirkwood, and Richardson in the lower temperature region. Unfortunately, the variation of the average value of the specific heat ratio, inaccuracies in the tables, and a lack of primary points make these tables too rough to use either with the I.B.M. integrations or the method of characteristics for the integration of the hydrodynamics of normal explosions. At the possible expense of some accuracy, therefore, the equation-of-state data have been smoothed so that they are suitable for these operations.

Wind Tunnels (17)

The Design of Low-Turbulence Wind Tunnels. Hugh L. Dryden and Ira H. Abbott. (*International Congress for Applied Mechanics, 7th, London, September 5–11, 1948, Paper.*) *U.S., N.A.C.A., Technical Note No. 1755,* November, 1948, 35 pp., illus., diagrs., figs. 34 references.

In the $4^1/_2$-ft. wind tunnel of the National Bureau of Standards and in the Langley two-dimensional low-turbulence pressure wind tunnel of the N.A.C.A., the magnitude of the turbulent velocity fluctuations is of the order of 0.0001 to 0.001 times the mean velocity. This characteristic has made possible the development of low-drag wing sections and the experimental demonstration of the unstable laminar boundary-layer oscillations predicted by a theory of Tollmein and Schlichting. While, heretofore, measurement of the drag coefficient of a sphere and the shift of transition from laminar to turbulent flow on a low-drag airfoil served as qualitative indications of the turbulence level of a wind tunnel, the development of low-turbulence designs depended greatly on the development of the hot-wire anemometer for turbulence measurements. By this technique, the root-mean-square of the components of velocity fluctuations can be determined, as can the average dimension of shape of the eddies in the flow. Thus, by measuring the decay of turbulence behind screens, the effect of damping screens on wind-tunnel turbulence could be ascertained. The technique made possible the measurement of the flow near a flat plate in air streams of varying turbulence and the measurement of the drag of specially designed low-drag airfoils. The paper contains a brief review of the state of knowledge in these various fields and shows how this knowledge was applied in wind-tunnel design to obtain low levels of turbulence.

Flow of a Compressible Fluid Past a Symmetrical Airfoil in a Wind Tunnel and in Free Air. Howard W. Emmons. *U.S., N.A.C.A., Technical Note No. 1746,* November, 1948. 31 pp., figs. 13 references.

The effects of compressibility on the flow about the NACA 0012 airfoil in a wind tunnel and in free air have been investigated by the relaxation method. The solutions obtained cover the cases of incompressible flow, compressible but sub-critical flow, and supercritical flow. Comparisons are made with experimental results and with approximate theories for compressibility effects and for wind-tunnel interference. The calculated results describe compressibility effects, as observed experimentally, considerably better than any of the well-known compressibility correction formulas. The calculated supercritical pressure distributions, including shock waves if present, agree well with experimental data.

Jet-Boundary-Induced-Upwash Velocities For Swept Reflection-Plane Models Mounted Vertically in 7- By 10-Foot, Closed Rectangular Wind Tunnels. Edward C. Polhamus. *U.S. N.A.C.A., Technical Note No. 1752,* November, 1948. 15 pp., figs. 3 references.

Numerical values in chart form, of the boundary-induced-upwash velocity necessary for the determination of the jet-boundary corrections for swept reflection-plane models mounted vertically in 7- by 10-ft., closed, rectangular wind tunnels.

Wind Tunnels in the Munich Area (L.F.M. and Peenemünde Tunnels). H. M. Garner, R. McK. Wood, and R. Smelt. *Combined Intelligence Objectives Sub-Committee, Item Nos. 26, 27, File No. 30–46.* 5 pp. British Information Services, New York. $0.20.

Brief description of the 2.8-m. high-speed subsonic variable-pressure wind tunnel at Ottobrunn; of the tunnel at Otztall, which, when completed, would have attained a Mach Number of 0.85 in a test section 8 m. in diameter and 14 m. long; and of the two supersonic 40 by 40 cm. intermittent wind tunnels evacuated from Peenemünde to Kochel.

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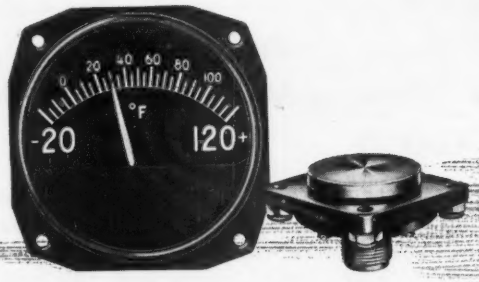

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Aeronautical Reviews

Books

Sources of Engineering Information

By Blanche H. Dalton. Berkeley, California, University of California Press, 1948. 109 pp. $4.00.

This is a pioneering book, designed as a reference source for all branches of engineering. It was developed from lectures to students and others at the University of California on the use of information sources as organized in the engineering library. The presentation is according to types of materials and reference tools, including periodical indexes, abstracts, and methods in the use of periodicals; bibliographies and bibliographic procedure; reference books of various types; the trade catalog collection; and standards and specifications. The section on reference books covers about 70 pages and deals with general works, biography, encyclopedias, technical dictionaries, handbooks and manuals, mathematical tables, physical tables, and manufacturers' directories.

The arrangement according to types of publications has limitations for the user looking for information on a particular subject. All the material relating to physics, for example, is not in one place, and it takes a little time to locate an item such as Parke's *Guide to the Literature of Mathematics and Physics* (New York, 1947), which is listed as a reference book under "Library Research," on page 38. Altogether, about 2,000 titles are recorded. As the book aims to cover all branches of engineering, the number of omissions for any one branch is necessarily large. A working library of engineering books for aeronautics, for example, would have to include about 1,500 titles, relatively few of which are included in this general list.

MAURICE H. SMITH
Librarian
Institute of the Aeronautical Sciences

For information on I.A.S. Library Service Facilities, see page 47

Statements and opinions expressed in Book Reviews are to be understood as individual expressions and not necessarily those of the Institute.

Book Notes

AERODYNAMICS

Control of Airplane Flight Path by Propulsive Jets. H. McKinley Conway, Jr. (Technical Publication No. 483.) Atlanta, Ga., 5009 Peachtree Road, Southeastern Research Institute, Inc., June, 1948. 21 pp.

The possibilities of a jet-airplane control system based on change of the thrust direction by installing controllable vanes in the nozzle are examined. The analysis indicates that a practical cascade of airfoils may be developed, providing adequate control of jet direction without serious interference with the flow leaving the jet nozzle. The discussion includes additional advantages of the system, such as improvement of the landing and take-off characteristics of present aircraft.

AIRPLANE DESIGN & DESCRIPTION

Fowler Flaps for Airplanes; an Engineering Handbook. Harlan D. Fowler. Los Angeles, Calif., Wetzel Publishing Co., Inc., 1948. 90 pp., illus., diagrs., figs. $5.00. (Corrected price.)

EDUCATION & TRAINING

Private Pilot Training. Primary Flying, Basic Ground School Training, Series 50, Meeting All Requirements of Civil Aeronautics Manual 50. Compiled and edited under the supervision of Harold E. Baughman and Iris C. Critchell. Los Angeles, Aviation Sales Corp., 1948. 374 pp., illus., diagrs. $4.00.

The purpose of this text is to provide the student and private pilot with ground-school text material on Civil Air Regulations, Air Navigation, Meteorology, General Service to Aircraft, Radio Usage, and Theory of Flight. It is intended also to bridge the gap between study for the private pilot rating and more advanced study. Copies of the latest editions of *Civil Air Regulations, Parts 20, 43, and 60, World Air Chart No. 350,* and one *Sectional Chart, Des Moines,* are included with the price of the book.

ELECTRONICS

Principles of Electric and Magnetic Fields. Warren W. Boast. New York, Harper & Bros., 1948. 405 pp., illus., diagrs. $4.75.

Designed for undergraduate students, this textbook emphasizes basic concepts, although the final third of the discussion covers supplementary aspects of electric and magnetic fields and requires a knowledge of elementary electric-circuit theory. A knowledge of the calculus is required of the reader. Each chapter is accompanied by a set of problems. The author is a professor of electrical engineering at Iowa State College.

ENGINEERING PRACTICES & AIDS

Dimensional Analysis of Engineering Designs. Vol. 1—Components (Part 1). (Gt. Brit., Inter-Services Committee for Dimensioning and Tolerancing of Drawings.) London, H. M. Stationery Office, 1948. 123 pp., diagrs. $2.35.

The purpose of the committee, whose work is published here in part, is to establish a basic system for tolerancing and dimensioning drawings of equipment, gages, jigs, and fixtures of various degrees of precision. The designated field of armament work has been interpreted in the widest possible sense, in order to provide a volume generally applicable to all engineering practices.

FUELS & LUBRICANTS

A.S.T.M. Standards on Petroleum Products and Lubricants. Methods of Testing, Specifications, Definitions, Charts and Tables. Philadelphia, American Society for Testing Materials, 1948. 745 pp. Paper binding, $5.50; cloth binding, $6.15.

This latest annual edition gives 108 test methods, 31 specifications, lists of definitions of terms relating to petroleum, materials for roads and pavements, and rheological properties of matter. Proposed methods of test are given in twelve appendixes.

METEOROLOGY

Weather Elements, a Text in Elementary Meteorology. 3rd Edition. Thomas A. Blair. New York, Prentice-Hall, Inc., 1948. 373 pp., illus., diagrs. $5.65.

This edition of a book last revised in 1942 includes new chapters on the characteristics of air masses and fronts and the relation of the weather to aviation. The chapter on forecasting has been rewritten and enlarged, with emphasis on upper-air charts and air-mass analysis. The discussions in other chapters, which deal with circulation zones and cells, fogs, thunderstorms, and instability, have been revised and expanded. New instrumental and observational techniques developed by the application of radar and electronic devices to meteorology have been included, and the excellent bibliography of about 125 items has been brought up to date.

Meteorological Codes. Annex 3 to the Convention on International Civil Aviation (Including Amendments 1 to 21). Montreal, International Civil Aviation Organization, September, 1948. 28 pp. $0.15.

Standards and recommended practices are given for the transmission of meteorological data, code forms, relevant symbols, and code tables. The meteorological part of the *Q Code* is included.

OPERATIONS

Rules of the Air. Annex 2 to the Convention on International Civil Aviation. Montreal, International Civil Aviation Organization, September, 1948. 20 pp. $0.15.

Standards and recommended practices are given for rules of the air in airspaces over the territory of contracting states and for aircraft of contracting states, including flight rules and rules for lights and visual signals.

Procedures for Air Navigation Services. ICAO Q Code. (ICAO Document No. 6100-COM/504.) Montreal, International Civil Avia-

tion Organization, August, 1948. 61 pp. $0.40; ring binder, $1.50.

This code, effective as of January 1, 1949, together with the following three documents reviewed below, replaces the *Communication Codes and Abbreviations* Document No. 2560-COM/164).

Procedures for Air Navigation Services. The Notam Code. (ICAO Document No. 6086-COM/505.) Montreal, International Civil Aviation Organization, September, 1948. 8 pp. $0.05. This code is provided for the coding of notices to airmen regarding radio aids, airports, lighting facilities, dangers to aircraft in flight or landing, and action regarding search and rescue.

Procedures for Air Navigation Services. Airline Abbreviations. (ICAO Document No. 6087-COM/506.) Montreal, International Civil Aviation Organization, September, 1948. 48 pp. $0.10. Cross-indexed abbreviations are given for use in radio-telephone and telegraphic communication.

Procedures for Air Navigation Services. Abbreviations of Addresses and Signatures. (ICAO Document No. 6135-COM/507.) Montreal, International Civil Aviation Organization, September, 1948. 4 pp. $0.05.

Dimensional Units to Be Used in Air-Ground Communications. Annex 5 to the Convention on International Civil Aviation. Montreal, International Civil Aviation Organization, September, 1948. 10 pp. $0.10.

Standards and recommended practices are given, with alternates, for units for distances, altitudes and elevations, horizontal and vertical speed, wind direction and wind speed, cloud height, visibility, altimeter setting, temperature, weight, and time.

COMMERCIAL

Personnel Licensing. Annex 1 to the Convention Civil Aviation. Montreal, International Civil Aviation Organization, September, 1948. 32 pp. $0.25. Standard and recommended practices are given for licenses and ratings for pilots, licenses for flight crew members and other personnel, and medical requirements.

Aircraft Weight and Balance Control. H. G. D'Estout. San Diego 10, Calif., Box 1484, Old San Diego Station, R. E. Peters, 1948. 49 pp., diagrs. $1.25.

This manual was written for the use of mechanics and for students aiming to obtain C.A.A. aircraft and aircraft-engine certificates. The author's aim is to simplify the appendix to C.A.A. Manual 18, by using only basic arithmetic and by the inclusion of problems and answers.

POWER PLANTS

JET & TURBINE

Gas Tables; Thermodynamic Properties of Air, Products of Combustion, and Component Gases; Compressible Flow Functions, Including Those of Ascher H. Shapiro and Gilbert M. Edelman. Joseph H. Keenan and Joseph Kaye. New York, John Wiley & Sons, Inc., 1948. 238 pp. $5.00.

These tables are a re-examination and recalculation of those presented in the authors' *Thermodynamic Properties of Air* (1945), all thermodynamic properties being based on the examination of data from spectroscopic sources that were published by F. D. Rossini and his coworkers of the National Bureau of Standards in 1945. The base temperature in this edition is taken to be zero on the absolute Fahrenheit scale, thus avoiding negative values of properties. Tables 30 to 53 are reprinted from Meteor Report No. 14, Massachusetts Institute of Technology, *The Mechanics and Thermodynamics of Steady One-Dimensional Gas Flow with Tables for Numerical Solutions*, by A. H. Shapiro, W. R. Hawthorne, and G. M. Edelman, December 1, 1947. Tables 55 to 59 are reprinted from Bumblebee Report 26, The Johns Hopkins University Applied Physics Laboratory, *The Theory and Practice of Two-Dimensional Supersonic Pressure Calculations*, by N. Edmonson, F. D. Murnaghan, and R. M. Snow, December, 1945. Altogether, 63 tables are presented. A bibliography of 28 items is included.

REFERENCE LITERATURE

HISTORY

Science at War. J. G. Crowther and R. Whiddington. New York, Philosophical Library, 1948. 204 pp., illus. $6.00.

The aim of the British Scientific Advisory Committee to the Cabinet in sponsoring this work was to make available an authoritative account of the contribution of British scientists to the war effort, which is based on official archives but written in nontechnical language. This aim has been admirably fulfilled. The four parts of the book deal with Radar; Operational Research (weapons, tactics, strategy); The Atomic Bomb; and Science and the Sea (submarine warfare, magnetic mines, underwater explosions, diving, etc.).

YEARBOOKS

Jane's All the World's Aircraft, 1948. New York, The Macmillan Co., 1948. 493 pp., illus. $20.00.

In this 36th edition *Jane's* is made even more useful than usual by the addition of indexes to the airplane and engine sections, including company names and popular names and model numbers. The airplane section comprises over two-thirds of the book and covers over 400 airplanes of 25 countries. The United States and Great Britain take up nearly two-thirds of the airplane section. About 50 Russian planes are described. Altogether, the book contains 582 photographs and three-view line drawings, of which 83 per cent are new. The sections on the air forces of the world and on civil aviation have been revised and cover, respectively, 46 and 60 countries.

(*Continued on page 83*)

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I.A.S. Sections

(*Continued from page 13*)

and that the program was progressing on schedule.

Principal speaker of the evening was Col. W. E. McDonald, Chief of Overseas Branch, Operations Division, U.S.A.F. His subject was "Operation Vittles," concerning the Berlin airlift over the Soviet blockade.

Colonel McDonald was assisted in his talk by Capt. A. W. Gullion. Additional guests were Brig. Gen. Frank P. Lahm (Ret.), President of the Early Birds, and Joseph P. Ryan, Advertising Manager of the AERONAUTICAL ENGINEERING REVIEW.

New York Section

R. Dixon Speas, *Secretary-Treasurer*

The December 2 meeting had as the principal speakers R. P. Kroon, Engineering Manager, and R. B. Rogers, Service Manager, Aviation Gas Turbine Division of Westinghouse Electric Corporation.

▶ **Jet Trends**—Title of their talk was "Trends in Turbojet Application and Maintenance." Kroon and Rogers spoke realistically of problems encountered today in the operation and maintenance of jet engines. Slides were shown, illustrating the aircraft presently using the subject engines and also showing the varying problems of engine and aircraft accessories required.

Sidney C. Hill, Assistant to Vice-President, Operations, of Scandinavian Airlines, and H. C. Towle, Jr., Chief of Thermodynamics, Republic Aviation, gave prepared discussions.

The film, *Air Power Is Peace Power*, produced jointly by Eastern Air Lines and Lockheed Aircraft, was shown.

San Francisco Section

John A. Stern, *Secretary*

Following officers were elected for 1949 at the November 4 meeting: Chairman, Prof. Elliott G. Reid; Vice-Chairman, Roy T. Nilsen; Treasurer, George B. McCullough; and Secretary, John A. Stern. Representative of I.A.S. to Nominating Committee for Area Councilors is Dr. R. G. Folsom.

▶ **Helicopter Flown**—Members witnessed flight demonstrations of the Hiller 360 helicopter, several members being afforded a ride. Following the demonstrations, a dinner-meeting was held to hear technical discussions of the Hiller helicopter by three engineers of United Helicopters, Inc ; 1948 Chairman Smith J. de France presided.

Wayne Weisner, Chief Engineer, gave a general description of the 'copter, first to receive its type certificate west of New York. Second speaker, Donald Jacoby, discussed flight testing of helicopters, while the last speaker, Joseph Stuart, III, described the control rotor on the Model 360.

Colored motion pictures showing practical applications of the model designed and built by United Helicopters were shown at conclusion of the talks.

Seattle Section

Robert M. Robbins, *Secretary*

At the November 18 meeting, 105 members were present to hear F. K. Kirsten, Professor of Aeronautical Engineering, University of Washington, deliver a paper on "Cycloidal Propulsion."

▶ **Not New**—Professor Kirsten prefaced his discussion by giving a brief history of the application of cycloidal propulsion, pointing out that the Chinese may have had cycloidal windmills 2,000 years ago.

After explaining the fundamental theory of cycloidal propulsion, he showed how it could be applied to surface vessels and how its use would eliminate the necessity for a rudder and at same time increase greatly the maneuverability of the ship.

A film illustrated the application on two different boats. Their maneuverability and performance were astounding.

▶ **For Electrical Energy**—Professor Kirsten predicted that cycloidal windmills might possibly replace water power as a primary source of electrical energy.

Student Branches

Academy of Aeronautics

Following a business session at the November 10 meeting, a film, *Airfoils* was shown. Chairman John Peter Keilp presided, with 55 members present.

University of Colorado

Dr. W. F. Hilton, British aerodynamicist and missile expert of the National Physics Laboratory, Great Britain, gave a talk at the November 22 meeting on the subject of "High Speed Airfoil Characteristics." Robert M. Wood, Chairman, presided, with 100 members present.

Dr. Hilton's talk dealt with aerodynamic problems in the transonic region and was illustrated by slides and motion pictures of airfoils at various Mach Numbers, supersonic tip speed of a propeller, and graphs.

University of Illinois

Main feature of the November 23 meeting was two films, *Elementary Aerodynamics* and *Construction of a Lightplane.*

Chairman Vernon F. Heyni gen said a few words about the Meetings and Papers Committee and asked for volunteers to act as reporters for the *Technograph*, a University of Illinois engineering publication. He also spoke about the requirements for I.A. S. officers. There was an attendance of 67 members.

At the December 1 meeting, Prof. H. S. Stillwell, head of the Aeronautical Engineering Department, introduced the speaker, John F. Haines, Research Director, Aeroproducts Division, General Motors Corporation.

Mr. Haines spoke on "Propeller Requirements for Lightplanes." There were 84 members present.

University of Illinois in Chicago

At the November 23 meeting, plans were made and committees formed for a Model Airplane Demonstration sponsored by the Branch on December 14.

Because of the resignation of the Vice-Chairman, Edwin A. Arveson, Jr., an election was held, and Jack Edward Jensen was chosen to fill the vacancy.

Iowa State College

A discussion of the advisability of founding a chapter of a National Honorary Fraternity for Aeronautical Engineers took up the first portion of the business meeting on November 30.

The Chairman, Ted Maehr, introduced the speaker of the evening, H. Brown, Chief Metallurgist of Solar Aircraft Company, on the subject of "The Importance of Metallurgy in Jet Engine Performance."

Mr. Brown gave a summary in comparatively nontechnical language of the present relationship of metallurgy and jet engine performance. He

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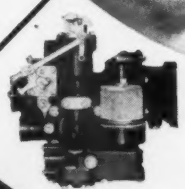

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CAL-AERO STUDENTS GAIN PRACTICAL EXPERIENCE

Students at Cal-Aero Technical Institute, who handle design problems as a regular part of classwork, are working on the sleek XLC-1 turbojet-powered small plane. Originally conceived as a class project for the engineering classes, the single-seater plane is expected to serve as a prototype for a personal-type aircraft with a gross weight of 1,278 lbs. (AERONAUTICAL ENGINEERING REVIEW, January, 1949). Here, Project Engineer Wayne Shank (left) checks a scale model of the tiny plane with Canadian student L. S. Pon (center) and C. F. Seifert.

stressed that the limitations of the present jet are not due to the inability of the metals being used to withstand the high temperatures involved. He also pointed out that present-day engines operated fairly close to the optimum temperature, as far as the metals are concerned.

In conclusion, he summarized the problems of the metallurgist in developing future gas turbines, as well as the present problem of finding a suitable low cost means of forming the metals in use.

Lawrence Institute of Technology

William Godchalk, student member, gave an interesting talk on channel wing aircraft at the November 9 meeting of this new Branch. Following the talk, a short film, *Sporting Wings*, was presented. Roy T. Heady, Chairman, presided.

Louisiana State University

A film, *Wright Air Supremacy*, was shown at the December 2 meeting, with John Paul Jones, Chairman, presiding.

New York University

The film, *Air Power Is Peace Power*, produced by Eastern Air Lines in cooperation with Lockheed Aircraft, was shown at the November 18 meeting. Nathan Kotlarchyk presided as Chairman, with 100 members present.

University of Notre Dame

Three films were shown at the December 1 meeting: *Birth of the B-29*, *Target Tokyo*, and *Reconnaissance Pilot*. There were 31 members present, with John P. Hoey, Chairman, presiding.

Ohio State University

With Faculty Adviser Prof. Edward Miller presiding members heard Lloyd Duane Yates, Graduate Instructor of the Aeronautical Engineering Department, talk on "Demonstration of Schaleron Apparatus."

With this apparatus, Mr. Yates showed the student body the heat waves arising from a heated soldering iron and also shock waves produced by discharging compressed air through a small orifice.

Other equipment demonstrated by Mr. Yates included the new Brown potentiometers used in the past summer in determining temperature variation during a blow-down from a large compressed air tank. Two films were shown: *Theory of Flight* and *Principles of Flight*.

Polytechnic Institute of Brooklyn

"Development of Landing Gear Design Loads" was the title of the talk given at the November 9 meeting, Donald E. Platz, Chairman, presiding.

Speaker L. M. Epps, Engineer in the Structures Group, Grumman Aircraft Engineering Corporation, stressed the need for an accurate evaluation of the design loads on the landing gear, since the weight of the wings and fuselage structure will be determined in large measure by the loads on the landing gear. He traced the methods of developing landing-gear design loads from the relatively crude methods used as recently as 10 years ago to present-day refinements necessitated by high landing speeds.

Mr. Epps gave a list of items that affect design loads and pointed out that in the present trend the drag load, the dynamic response of the structure, and the time correlation between the peak vertical drag and side loads are assuming greater importance in developing design loads.

In conclusion, the speaker stated some of the problems that must be solved before more accurate evaluations of landing-gear design loads can be made. He mentioned the need for more statistical data with regard to service life, for better instruments to measure the variables experimentally, and for better methods of obtaining dynamic behavior of the landing-gear structure.

Oregon State College

Student members heard Lt. Jack Blodgett, Instructor of Communications, R.O.T.C., at Oregon State, speak on "Communications Problems of the Polar Region" at the November 10 meeting. Chairman Curt Privett presided.

Lieutenant Blodgett briefly explained the wave lengths used in communications and the difficulties experienced in the polar regions. Wire communication cannot be used to any great advantage, he said, because the average wind velocity is 60 m.p.h. and insulation does not hold up in the cold weather.

Communications objectives to be reached in the Arctic are: (1) develop a type of communication that will work from ground to air over a long range; (2) develop radar that works in the Arctic; (3) design power equipment that will be equally suitable for any place on earth.

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According to Lieutenant Blodgett, the burden of designing, maintaining, and operating this equipment will fall on those in the schools today.

Purdue University

The McDonnell Aircraft film, *Experimental Aircraft of McDonnell Aircraft Corporation*, together with the talk by Thomas Peppler, Chief Flight Test Engineer of M.A.C., featured the November 16 meeting.

Kenneth Jordan, Chairman, presided with 80 members and guests present. With new members, the Branch membership now totals 100.

Rensselaer Polytechnic Institute

On November 18, 150 members heard Lieutenant Colonel Fleming, Chief of Fighter Test Section, Wright Field, speak on "Jet Pilot Training."

His talk centered on the discussion of the many problems and hazards encountered in high Mach flights in jet planes, including oxygen supply, pressurization, and vision.

Despite many advances in pilot-ejection units, Colonel Fleming said most pilots will still take their chances on "crawling out of the cockpit." The ejection unit, he said, has a force equivalent to 16g's acting on a pilot for 0.2 sec.

Stanford University

A field trip to United Helicopters plant at Palo Alto was made December 1 under leadership of Wendell P. Garton, Chairman of the Branch. The amazing maneuverability of the rotary wing plane was demonstrated by Joseph Stuart, III, Project Engineer, United Helicopters.

Wayne Weisner, Engineering Manager, talked to the group on the general characteristics of United's helicopter, while Donald Jacoby, Aerodynamicist and Flight Test Engineer, spoke on the C.A.A. test for certification.

Stewart Technical School

At the November 3 meeting, a film *Army Air Forces Comes of Age* was shown which followed the development of the A.A.F. prior to and after Pearl Harbor. William Blau, Chairman, presided. There were 39 members present.

A second film, shown at the November 17 meeting, entitled *A Thunderbolt Is Made*, showed the processes of production from procurement, storage, and fabrication of various elements until final assembly and testing of the P-47.

Tri-State College

Following the showing of three films at the November 22 meeting, Dino H. Kintis, a Student Member, spoke on "Marketing Problems."

Mr. Kintis broke down the industrial procedures into two parts: Production, which includes all activities relative to the actual making of the product; and Sales, which handles the distribution. It was on the latter part that the speaker dwelt.

At the December 1 meeting, final meeting of the Fall term, plans were discussed for the forthcoming Term Banquet held on December 9 at which the speaker of the evening was Milton J. Kittler, Vice-President & Chief Engineer of Holley Carburetor Company, Detroit.

Reports also were given on the two projects in progress within the Branch. Preliminary tests and calculations have been completed on the V-Tail Project, and the final report is expected early this Spring.

The films, *Riveting Aluminum* and *Welding Aluminum*, were shown, the final ones in a series depicting the methods and processes used in the procurement and development of aluminum for industrial purposes.

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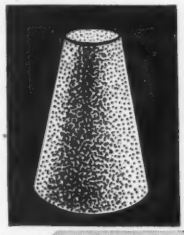

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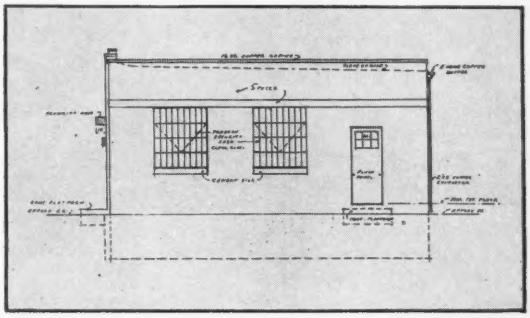

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AMERICA'S STANDARD FOR OVER 25 YEARS

New officers for the Winter Term are as follows: Chairman, Edward C. Klein; Vice-Chairman, Harry D. Ballard; Secretary, Harry L. Roland; Treasurer, John F. Reinsch; Student Council, Francis C. Townes. Branch Reporter is Raymond F. Boose.

West Virginia University

A business meeting was held November 17 at which an amendment to the By-Laws was passed. Three films were shown, including *The Modern Flying Carpet*, *Planes Without Pilots*, and *Jet Propulsion*.

University of Wyoming

Election of officers at the November 9 meeting resulted as follows: Chairman, John L. Bailey; Vice-Chairman, Eugene M. Marshall; Secretary-Treasurer, Alvin J. Brungard; Honorary Chairman, Laurence R. Soderberg.

A decision was made to have meetings bi-monthly and dues of $0.75 quarterly

News of Members

(*Continued from page 13*)

Division as Flight Engineer, flying the route from New York through Paris to Cairo on the Model 749 Connies and DC-4 Skymasters. He recently was appointed to the board of engineers representing the Airline Flight Engineer Association of Wilmington-New Castle Section.

Subramania Ramamritham left New York to accept an appointment as a senior Scientific Officer in the Indian Civil Aviation Directorate in New Delhi.

Rodger F. Ringham, Aerodynamics Engineer of Chance Vought Aircraft, Stratford, Conn., has migrated with the company to Dallas.

Frederick H. Roever is now with McDonnell Aircraft Corporation as Engineering Planner.

E. F. Schmidt, last listed as an Ensign assigned to the Chinese Shakedown Dept., Guantanamo, Cuba, has just reported that he is Research Aeronautical Engineer at Cornell Aeronautical Laboratory since June, 1946.

Hector R. Skifter, President, Airborne Instruments Laboratory, predicted all-weather flying will become routine for commercial air lines only after an elaborate electronic computer has been developed and proved capable of handling national traffic control pattern. Such a device, Mr. Skifter believes, "is possible within the next 10 years, if we all work hard at it."

Joseph William Straayer is Stress Analyst at Boeing Airplane Company, Seattle.

Frank F. Taranto is with Wright Aeronautical Corporation, Wood-Ridge, N.J., as Senior Test Engineer. He had been a Stress Analyst at Boeing—Seattle.

Kurt P. Wagenknecht is with McDonnell Aircraft Corporation as a Project Planner. He was with Trans World Airlines as Production Control Supervisor, International Division in Delaware.

Allen O. Whipple, Jr., who left Chance Vought Aircraft last June is with Civil Air Transport, Washington, D.C., as Administrative Assistant Purchasing Agent.

Members Elected

The following applicants for membership or applicants for change of previous grades have been admitted since the publication of the list in the last issue of the Review

Elected to Associate Fellow Grade

Bennett, Arthur L., Ph.D. in Astronomy, Head, Ballistics Div., Naval Ordnance Test Station (Inyokern).

Trapnell, Frederick M., B.S., Captain, Naval Aviator, U.S.N.; Coordinator of Tests at Naval Air Test Center (Patuxent River).

Zakhartchenko, Constantine L., M.S.-Ae.E., Consultant, Cornell Aero. Lab.

Transferred to Associate Fellow Grade

Hamilton, Dale, Design Engineer, Piasecki Helicopter Corp.

Vincenti, Walter G., Engineer (Aero.), Research Specialist in Supersonic Aerodynamics, N.A.C.A. (Moffett Field).

Elected to MEMBER Grade

Buss, Robert A., Supervisor of Pilot Ground School, Western Air Lines, Inc.

Champion, Robert Louis, M.A., Professor, Airways Design, Aero. Institute of Technology; President, Aviation Facilities Associates, Inc. (Rio de Janeiro).

deRussy, John H., Col., U.S.A.F.; Chief, New Developments Div., Air Command & Staff School, Air University (Maxwell Air Force Base).

D'Estout, Henri G., Inspector, Aircraft Service, Non-Scheduled Maintenance Div., Civil Aeronautics Administration.

Feigenbaum, David, B.M.E., Sr. Research Engineer, Cornell Aero. Lab.

Foster, John J., Technical Advisor, Aircraft Product Development, H. I. Thompson Co.

Halpine, Charles Greham, M.S. in Ae.E., Capt. (Retired), U.S.N.

King, Barry Griffith, Ph.D. (Physiology), Chief, Aeromedical Design & Material Div., Office of Aviation Safety, Civil Aeronautics Administration, Dept. of Commerce.

Krieger, Andrew E., Jr., Lt. Col., U.S.A.F.; Asst. Chief, New Developments Div., Air Command & Staff School, Air University (Maxwell Air Force Base).

Lo, Hsu, Ph.D., Aero. Research Scientist, N.A.C.A. (Langley Field).

Ohman, Clifford Byron, B.Ae.E., Designer "B," Consolidated Vultee Aircraft Corp.

Rand, Thorkild, Ph.D., Chief, Static & Aeroelasticity Research, Research Dept., SAAB (Sweden).

van Zelm, Willem D., Chief of New Design, The Glenn L. Martin Co.

Transferred to MEMBER Grade

Borst, Henry V., B.S. in Ae.E., Sr. Aerodynamicst, Propeller Div., Curtiss-Wright Corp.

Breslow, Stewart Homer, B. of Ae.E., Project Engineer, 24C Design & Project Section, Westinghouse Electric Corp.

Cournyn, John B., M.S. in Engineering, Aero. Engineer, Ship Aircraft Coordinator, Bureau of Aeronautics, Navy Dept.

Eggers, Alfred John, Jr., B.S., Aero. Research Scientist, High Speed Research Div., Ames Aero. Lab., N.A.C.A.

Fleddermann, Richard Grayson, M.S. in Ae.E., Research Assoc. in Aerodynamics, University of Michigan.

Gearhart, Jack Bruce, M. of Ae.E., Flight Test Engineer "A," Northrop Aircraft, Inc.

Miller, Robert A., B. of Ae.E., Aerodynamicist, Fairchild Pilotless Plane Div., Fairchild Engine & Airplane Corp.

Pierpoint, Thomas Reynolds Vice-President, American Helicopter Co. (Los Angeles).

Rama Rao, Muthyala Venkata, B.E., Design Draftsman, Letecke Zavody, N.P.

Ross, Sol Alexander, B.S. in M.E., Aerodynamicist, Aerophysics Dept., Goodyear Aircraft Corp.

Theriault, Paul William, B.S. in Ae.E., Dept. Mgr., Wind Tunnel, Lockheed Aircraft Corp.

Townsend, Thomas Hewell, Jr., B. of Ae.E. and B.S. in M.E., Instructor of Statics & Dynamics, Mechanical Engineering Dept., Mississippi State College.

Wallach, Bernard H., B.M.E., Development Engineer, Servo Corporation of America.

Watson, Douglas C., B.Ae.E., Project Engineer, Edo Corp.

Elected to Associate Member Grade

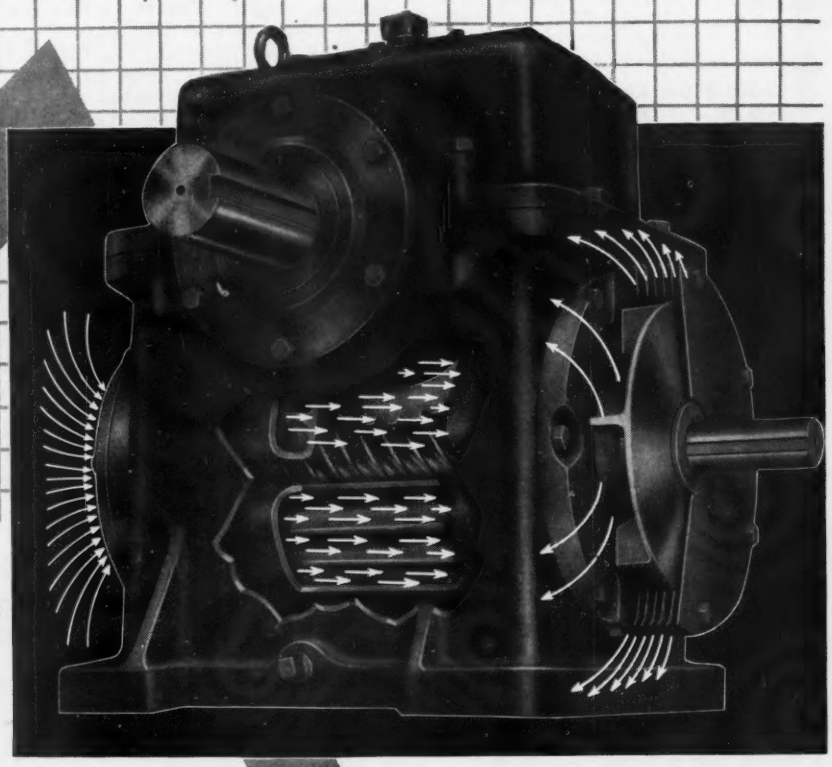
Kuenzli, Alfred E., A.B., Editor—*Technical Data Digest,* Air Documents Div., Intelligence Dept., Air Materiel Command (Wright-Patterson Air Force Base).

Meskel, Thomas John, B.S., Mgr., Member Services, Institute of the Aeronautical Sciences, Inc.

Raymond, William Thorpe, LL.B., Dir., Governmental Affairs, Air Transport Association.

Transferred to Associate Member Grade

Dastur, Jehangir C., Engine & Aircraft Maintenance Inspector, Jr. Grade I, Air Services of India, Ltd.



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Mehta, Rai Singh, Aero. Mechanic, Indian National Airways, Ltd. (New Delhi).

Elected to Technical Member Grade

Benulis, Walter Edward, B.S. in Ae.E., Liaison Engineer, Fairchild Aircraft Div., Fairchild Engine & Airplane Corp.

Crespo, Sergio, M. of Ae.E., Capt., Engineering Branch, Chilean Air Force.

Gill, John D., B.S. in M.E. (Aero.), Rocket Research Engineer, Process Div., Special Projects Dept., M. W. Kellogg Co.

Kelso, George Charles, Engineering Draftsman, Aerodynamics Dept., North American Aviation, Inc.

Transferred to Technical Member Grade

Allen, Ralph Arthur, B.S. in Ae.E., Power Plant Engineering Draftsman, Boeing Airplane Co. (Seattle).

Anderson, Harvey Edward, B.S. in Ae.E., Aircraft Mechanic (Experimental), Boeing Airplane Co. (Seattle).

Ashkenas, Harry, M.S., Research Engineer, California Institute of Technology.

Bacus, Faustino B., A.A., Engineering Draftsman "B," Northrop Aircraft, Inc.

Baker, Marvin E., Capt., Pilot, U.S.A.F.; Project Engineer, Hdqs., Air Materiel Command (Wright-Patterson Air Force Base).

Brown, Robert Benton, B.S. in Ae.E., Aerodynamicist, Boeing Airplane Co. (Seattle).

Celniker, Leo, M.S.

Ciccotti, James Mario, B.S. in Ae.E., Aero. Engineer, Technical Intelligence Div., Aircraft Section, Wright-Patterson Air Force Base.

Coon, Lloyd Ralph, B.S., Aero. Engineer P-1, N.A.C.A. (Langley Field).

Craft, Richard D., Engineering Draftsman "A," Electronics Dept., Hughes Aircraft Co.

Crowe, William Michael, Jr., Minor Detail Draftsman, Republic Aviation Corp.

D'Aiutolo, Charles Thomas, B.A.E., Aero. Engineer P-1, N.A.C.A. (Langley Field).

Davis, Milton Willard, B. of Ae.E., Research Engineer, United Aircraft Corp.

de Oliveira, Leao Goncalves, A.A. in Ae.E., Engineer, D.E.T.A., T.A.P. (Portugal).

Dilworth, Marcus Clayton, B.S., Engineering Draftsman, Consolidated Vultee Aircraft Corp. (Ft. Worth).

Galentine, Paul G., Jr., 1st Lt., Pilot, U.S.A.F.

Gensel, Theodore Reginald, Draftsman, The Glenn L. Martin Co.

Guerin, Roland L., Jr., B.S. in Ae.E.

Hare, Paul White, Jr., B.S., Structural Design Engineer, Chance Vought Aircraft Div., United Aircraft Corp.

Hauser, George H., Jr., M.S.E., Flight Test Engineer, Air Materiel Command, Wright-Patterson Air Force Base.

Hayes, Robert D., M.S. (Aero), Mechanical Engineer, Geneva Steel Co.

Hermann, Paul J., B.S. in Ae.E., Instructor in Theoretical & Applied Mechanics, Iowa State College.

Klein, Norbert Herman, B.S. in Ae.E., Aero. Engineer, Piasecki Helicopter Corp.

Langley, George Raymond, A.A. in Ae.E., Jr. Engineer, Boeing Airplane Co. (Seattle).

Lied, Alf S., Engineer, Boeing Airplane Co. (Seattle).

McDermott, Andrew Charles, B.S. in Ae.E., Draftsman, Universal Oil Products Co.

McHenry, Gordon, B.Ae.E., Engineering Technician, Dynamics Section, Lockheed Aircraft Corp.

McNay, Curtis Eugene, B.S. Ae.E., Designer, Solar Aircraft Co.

Mielke, Florren Walter, B.S. in Ae.E., Sr. Draftsman, Goodyear Aircraft Corp.

Mosena, Melbourne L., B.S., Planning Engineer, North American Aviation, Inc.

Newman, Morris, B.S. Ae.E.

Paglianete, Francis Joseph, B.S. in Ae.E., Flight Test Engineer, Air Materiel Command, Wright-Patterson Air Force Base.

Prough, Robert L., "B" Draftsman, Douglas Aircraft Co., Inc. (El Segundo).

Royal, Edmund Robert, Equipment Engineering, Detail 3, General Electric Co.

Schmitt, Thomas Joseph, B.S. in Ae.E., SP-5 Engineering Aide, David Taylor Model Basin, Navy Dept.

Sheppard, Milton H., Jr., B.S., Engineer, Parks Aircraft.

Snitkoff, Joseph, B. of Ae.E., Stress Engineer, Goodyear Aircraft Corp.

Steen, Clarence H., B.S. in Ae.E., Acting Air Force Secretary, Committee on Scientific & Synthetic Analysis, Research & Development Board, U.S.A.F. (Washington, D.C.).

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Thompson, Hugh Bradley, M. of Ae.E., Aerodynamicist "A," Northrop Aircraft, Inc.

Thorson, Kenneth Raymond, B.S. in Ae.E., Stress Analyst, Boeing Airplane Co. (Seattle).

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Wick, Robert S., M.S., Instructor, Fluid Mechanics, Dept. of Mechanical Engineering, L. C. Smith College of Applied Science, Syracuse University.

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Zobel, Edward Charles, B.S. in Ae.E. Instructor in Engineering Mechanics, Wayne University.

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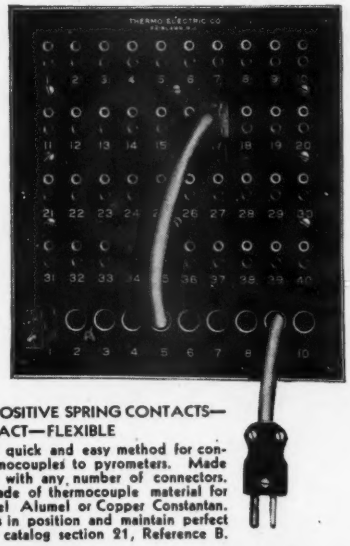

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Thermodynamicist; Flutter Engineer—M.S in engineering, with some training in aeronautics. Thorough mathematical background, working knowledge of compressible fluids, engineering thermodynamics and heat transfer, experience in gas-turbine work preferred. For analysis and development work on engines for advanced military aircraft. Also Flutter Engineer: A.E. graduate with several years' experience in flutter and vibration problems. Salaries commensurate with training and experience. Please include complete summary in reply to Engineering Personnel Office, North American Aviation, Inc., Los Angeles Airport, Los Angeles 45, Calif

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Engineers—Engineering draftsmen, engineering designers, and aerodynamicists for research and development work on B-36, world's largest bomber, and other advanced Air Force designs. Positions are also available for tooling personnel. Write for application blank to Engineering Personnel Office, Consolidated Vultee Aircraft Corporation, Fort Worth, Tex.

Research Engineer—For analysis of internal flow conditions and stress design of motor cases for jet propulsion devices. Five to 15 years of technical experience preferred. Jet propulsion experience helpful but not necessary. Problems involve knowledge of some thermodynamics, fluid flow, and stress analysis. This represents an opportunity with a young and rapidly growing activity. Salary offered will depend on experience. Write to: Thiokol Corporation, Elkton Division, Box 244, Elkton, Md.

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Aeronautical, Electronic, and Electrical Engineers—The Aeronautical Structures Laboratory of the Naval Air Experimental Station is seeking engineers in several fields for employment in Philadelphia, Pa. Fifteen vacancies exist for aeronautical, electrical, and electronic engineers and engineering aides. Applications are desired from persons who have had training and experience in the fields of engineering described below. Applications for the positions should be made on Standard Form 57, available at any first- or second-class post office, and should be mailed to Industrial Relations Officer, Naval Air Material Center, U.S. Naval Base Station, Philadelphia 12, Pa. **Aeronautical Engineers** (Structures)—Structural development and flight tests. Analysis of loads in aircraft components imposed by high air speeds and accelerations; static and dynamic testing of aircraft structural features; development of test equipment, methods, and procedures; analysis of data; and preparation of reports. Six P-1 grades at $2,974.80 per year and three P-2 grades at $3,727.20 per year are open. **Electrical and Electronic Engineers**—To develop, evaluate, and operate special laboratory and flight-test equipment. Includes direct and remote recording (Telemetering) equipment, the pickup instruments, such as strain gages, accelerometers, air-speed indicators, altimeters, etc. One P-1 grade at $2,974.80 per year, two P-2 grades at $3,727.20 per year, and two P-3 grades at $4,479.60 per year are open. **Engineering Aides**—Provide assistance to professional engineers performing the duties described above. Prepare sketches for laboratory test preparations. Provide liaison between laboratory and engineering offices. Record data such as strains and deflections. Make tabular calculations and prepare graphs as direct. One SP-5 position is open; salary $2,724 per year.

Electrical Engineer—To coordinate and develop electrical equipment for rocket motor projects such as ignition systems, starting, instrumentation, test equipment, interlock and limit switches; should be familiar with aircraft standards. Address: Administrative Engineer, Rocket Department, Curtiss-Wright Corporation, Propeller Division, Caldwell, N.J.

Liaison Engineer—Basically a good designer familiar with rocket motor development to coordinate development work of staff engineers with customer and contract requirements. Address: Administrative Engineer, Rocket Department, Curtiss-Wright Corporation, Propeller Division, Caldwell, N.J.

Technical Writer—To prepare service, operation, overhaul, and similar data on rocket motors and their associated equipment. Address: Administrative Engineer, Rocket Department, Curtiss-Wright Corporation, Propeller Division, Caldwell, N.J.

The number preceding the notices represents the Box Number of the Institute of the Aeronautical Sciences to which inquiries should be addressed.

Aircraft Dynamics Engineers—For research work on subsonic and supersonic flutter, vibration, dynamic loads, stability and control of supersonic missiles, and helicopter dynamic problems. Applicants must have good background in fundamentals of applied mechanics and mathematics. Advanced degree or previous experience in field is essential. Salaries commensurate with training and experience. Cornell Aeronautical Laboratory, Employment Office, 4455 Genesee St., Buffalo 21, N.Y.

Helicopter Engineer—Experience in helicopter aerodynamics and stress analysis required. Apply in writing with a résumé of experience and education to American Helicopter Company, 900 N. La Brea Ave., Inglewood, Calif.

930. General Manager—For long-established company, near Cleveland, manufacturing both commercial and aircraft pumps for oil, fuel, air, and for water injection, also valves, etc. Management experience encompassing the direction of sales and familiarity with Navy and Air Force contract procedures and requirements are essential requisites for this position. Preferential consideration will be given if such experience is supplemented by intimate knowledge of design, manufacture, and sales of pumps. Company has good supporting organization and has maintained excellent labor relations. Outstanding prospects for a successful future for right man. Application must give complete information of past experience and management background with at least two responsible references. Also state salary requirement.

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939. Aeronautical Instructor—Administrator—Unusual background: Degree in physics, also major in chemistry, Johns Hopkins. Three years teaching and administrative experience, U.S.A.F. technical schools in engine test, carburetion specialization, flight-line maintenance. Instructor in aviation mechanics for the Brazilian Air Force and assistant chief of the Engineering Projects Division for the Brazilian Ministry of Aeronautics, serving as administrative chief of 400 Brazilian technicians. Considerable experience in personnel administration in the U.S.A.F. as civilian chief instructor and also as engineer in Brazil. Has just returned from a 3-year stay in South America. This last year spent only in traveling and observing all South American countries. Can speak and write fluent Portuguese and Spanish. Any location.

938. Personnel Manager—B.S. Ae.E. and M.S. in Industrial Psychology, both Purdue. Two years engineering department international air line. Present position—personnel manager, West Coast firm. Location open.

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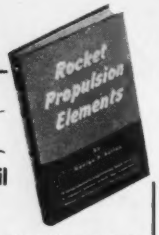

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934. Instrumentation and Liaison Engineer—Twelve years' all-around experience on experimental reciprocating type aircraft. Three and one-half years specializing on development, manufacturing, and installation of special instrumentation for experimental jet aircraft. Some experience on instrumentation on guided missiles. Desires position on West Coast or in South in related work. Single, age 29; free to travel; would consider service engineering position.

932. Engineering, Management, or Administration—B.S. in M.E. and Masters Degree in A.E. Over 20 years' experience in aircraft and missile design, manufacture, and flight test involving C.A.A., Army, and Navy. Directly responsible for design of at least eight airplanes. Detail experience includes 13 years of stress analysis, project design, testing, flight test. The last 7 years of this period supervised all of the above in capacity of chief engineer. Factory manager responsible for planning, tooling, and production for 3 years, then assistant general manager. Manager of divisions of two large corporations for the last 5 years. Desires responsible position as engineering or management executive.

931. Engineer-Lawyer—B.S. in M.E. (Aeronautical Option) in 1942. Four years' experience; 1 year in stability research in a N.A.C.A. wind tunnel; 3 years in the Navy as maintenance of aircraft and in BuAer as assistant on a design desk. Will graduate from Stanford Law School, May, 1949. Desires position in which both backgrounds will be useful. Prefers West Coast.

929. Aeronautical Engineer—Fourteen years' experience, last 10½ in aircraft design. B.S. in M.E. 1934 from Guggenheim School of Aeronautics of New York University. Has held position as designer, project engineer, chief aerodynamicist, and acting chief engineer and has been active in design of metal and wood aircraft for Navy and civil use, helicopters, and propellers. Desires responsible position requiring imagination and activity. East Coast preferred.

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924. **Engineer**—Graduate (Majors in Physics and Mathematics) of University of California. One year's graduate work in Physics. Five years' experience as a stress analyst and dynamicist in aeronautical engineering.

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Book Notes

(*Continued from page 68*)

SCIENCES, GENERAL

MATHEMATICS

Tables of Bessel Functions of Fractional Order. Vol. 1. Computation Laboratory of the National Applied Mathematics Laboratories, National Bureau of Standards. New York, Columbia University Press, 1948. 413 pp. $7.50.

Tables are presented for the fractional orders $J_\nu(x) = \pm 1/3, \pm 2/3, \pm 1/4$, and $\pm 3/4$, occurring in such problems of applied mathematics as elasticity, head conduction, hydrodynamics, and wave theory. A bibliography of 30 texts, tables, and articles on theory and physical applications is included.

Eleven and Fifteen-Place Tables of Bessel Functions of the First Kind, to All Significant Orders. Enzo Cambi. New York, Dover Publications, Inc., 1948. 154 pp. $3.95.

The main table gives $J_n(x)$ for x varying from 0 to 10.5 at intervals 0.01 to 11 places, and for $n = 0$ (1) 29. A supplementary table gives $J_n(x)$ for x varying from 0 to 0.5, at interval 0.001, to 15 places of decimals; n is extended up to $n = 11$—that is, through all values of $J_n(x)$, for the range of x in question, which are greater than 10^{-15}.

STRESS ANALYSIS & STRUCTURES

Plastic Deformation, Principles and Theories. L. N. Kachanov, N. M. Beliaev, A. A. Ilyushin, W. Mostow, and A. N. Gleyzal. Ed. by Henry H. Hausner. Brooklyn 4, N.Y., 5414 17th Ave., Mapleton House, 1948. 192 pp., diagrs. $8.00.

Contents: On the Mechanics of Plastic Solids, by L. N. Kachanov; Theories of Plastic Deformation, by N. M. Beliaev; Some Problems in the Theory of Plastic Deformations, by A. A. Ilyushin; Relation Between the Theory of Saint Venant-Levy-Mises and the Theory of Small Elastic-Plastic Deformations, by A. A. Ilyushin;

The Theory of Small Elastic-Plastic Deformations, by A. A. Ilyushin; Plastic Deformation of Thin Plates Under Hydrostatic Pressure, by Wolfe Mostow; Plastic Deformation of a Thin Circular Plate Under Pressure, by A. N. Gleyzal. The first five papers were translated for The David W. Taylor Model Basin from Russian sources published between 1937 and 1946. The last two papers report research done under direction of the U.S. Navy during World War II. The papers are reproduced by permission of the U.S. Office of Technical services

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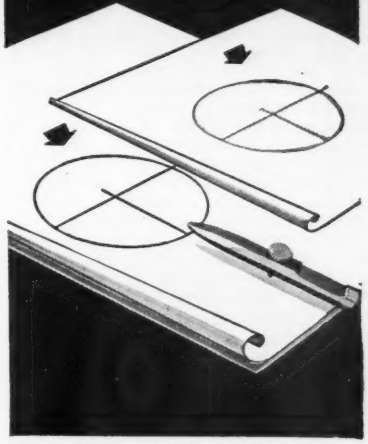

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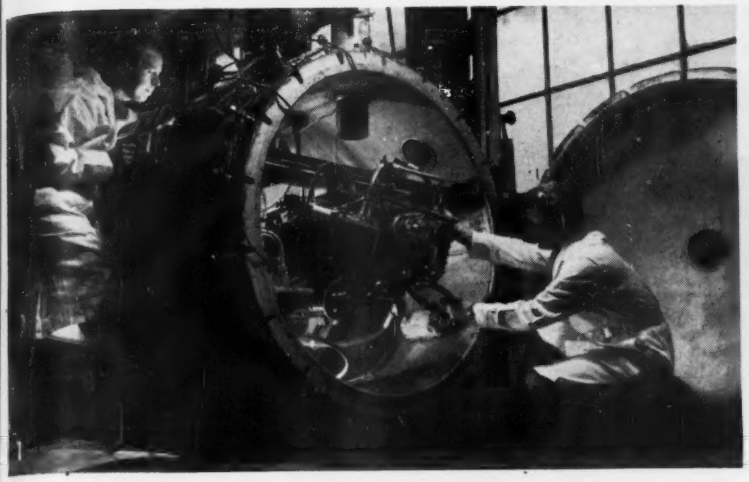

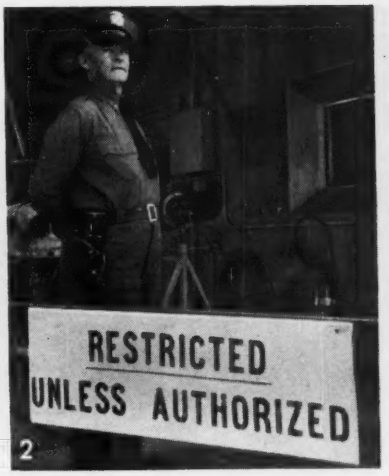

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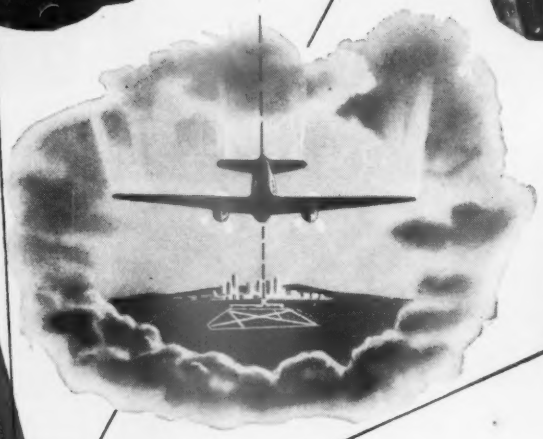

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